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FINAL AREA OF CONCERN 6 (AOC 6) TNT SUBAREAS REMEDIAL INVESTIGATION  
REPORT FISC WILLIAMSBURG VA  
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CH2M HILL

Final

# **AOC 6 TNT Subareas Remedial Investigation Report**

**Naval Weapons Station Yorktown, Cheatham Annex  
Williamsburg, Virginia**

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# Executive Summary

This report presents the findings of the Remedial Investigation (RI) at the Area of Concern (AOC) 6 Trinitrotoluene (TNT) Graining House Sump and TNT Catch Box Ruins subareas (AOC 6 TNT Subareas), Naval Weapons Station (WPNSTA) Yorktown, Cheatham Annex (CAX), in Williamsburg, Virginia. Based on the results from previous investigations, the RI was conducted to characterize the nature and extent of contamination within soil and groundwater to assess the potential risks posed by exposure to contamination for human and ecological receptors. Surface water and sediment analytical data were previously collected at the AOC 6 TNT Subareas during the 2012 Site Inspection (SI) (CH2M HILL, 2012). However, since no potential human health or ecological risks were identified for sediment and surface water based on results of the SI, and since these media are currently being assessed as part of the Penniman Lake SI, they were not evaluated in this RI.

The objectives of the RI have been achieved – data gaps have been filled, the nature and extent of contamination have been sufficiently defined, the conceptual site model (CSM) has been updated to reflect the compilation of data from all investigation activities to-date, and human health and ecological risks have been assessed.

Soil and groundwater sampling at the AOC 6 TNT Subareas indicate that the extent of contamination within soil has been delineated and consists primarily of two separate areas to the immediate southeast and northeast of the foundation of the former TNT Graining House.

The sources of contamination at the AOC 6 TNT Subareas are considered to be potential sources of historical leakage or discharge from the former TNT Graining House Sump and/or TNT Catch Box Ruins. The former TNT Catch Box Ruins were used to separate TNT particles from wastewater. Historical leakage or discharge represent the only identified source of CERCLA-regulated contamination at the AOC 6 TNT Subareas. Based on the data evaluations presented in this RI, the following potentially site-related constituents of concern (COCs) posing risks to either human health or the environment were identified:

Risk Component	Medium		
	Surface Soil	Subsurface Soil	Groundwater
Human Health	2,4,6-trinitrotoluene (TNT), 2-nitrotoluene, arsenic, hexavalent chromium, and lead*	TNT, 2-nitrotoluene, arsenic, and hexavalent chromium	Arsenic and iron
Ecological	TNT and lead	TNT and lead	No unacceptable risks to aquatic biota identified

\*Unlike the other listed COCs, lead is not a COC when evaluating exposure to lead in soil across the full site; however, if only exposed to soil within the Catch Box Ruins, lead is a COC for Catch Box Ruins surface soil and combined surface and subsurface soil.

A Focused Feasibility Study (FFS) is recommended to develop and evaluate remedial alternatives to address potentially unacceptable human health or ecological risks associated with TNT and lead in soil at the AOC 6 TNT Subareas. Since the size of the AOC 6 TNT Subareas is relatively small (approximately 0.5 acre) and the approximate boundaries of the TNT and lead contamination in soil are defined, an FFS would allow for a more efficient evaluation of several selected potential remedial alternatives. No further action is recommended for arsenic and hexavalent chromium in soil. The arsenic concentrations are within the range of background. Hexavalent chromium was not detected in surface soil and in subsurface soil, the risk to a residential receptor would fall within the acceptable risk range for this constituent.

Since there was only one detection of the human health COC 2-nitrotoluene, the risks associated with exposure to it across the site are likely over-estimated, and since this one detection is within the

approximate distribution of TNT contamination south of the former TNT Graining House Sump, it would be addressed as part of the FFS remedial alternatives associated with TNT in this area, such that no further action with respect to 2-nitrotoluene is warranted.

In addition, no further action is recommended for groundwater since the groundwater data evaluated during this RI indicate that the concentrations of arsenic and iron in groundwater are likely attributable to naturally occurring background conditions and not from historical leakage or discharge from the former TNT Graining House Sump and/or TNT Catch Box Ruins.

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# Acronyms and Abbreviations

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°C	degree Celsius
°F	degree Fahrenheit
µg/kg	microgram per kilogram
µg/L	microgram per liter
amsl	above mean sea level
AOC	area of concern
atm-m <sup>3</sup> /M	atmosphere per cubic meter per mole
BCF	bioconcentration factor
bgs	below ground surface
CAX	Cheatham Annex
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
CTE	central tendency exposure
DI	deionized
DNT	dinitrotoluene
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
ER	environmental restoration
ERA	Ecological Risk Assessment
ERP	Environmental Restoration Program
ESV	ecological screening value
FFS	Focused Feasibility Study
f <sub>oc</sub>	fraction of organic carbon
ft/day	foot per day
g/cm <sup>3</sup>	gram per cubic centimeter
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
HSA	hollow-stem auger
ID	inside diameter
IDW	investigation-derived waste
K	hydraulic conductivity
K <sub>d</sub>	distribution coefficient
K <sub>h</sub>	horizontal hydraulic conductivity or Henry's Law Constant
K <sub>oc</sub>	organic carbon partition coefficient
K <sub>ow</sub>	octanol-water partition coefficient
MCL	maximum contaminant level
mg/kg	milligram per kilogram

mg/L	milligram per liter
ml/g	milliliter per gram
MS	matrix spike
mS/cm	milliSiemen per centimeter
MSD	matrix spike duplicate
mV	millivolt
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
ORP	oxidation-reduction potential
PCB	polychlorinated biphenyl
PID	photoionization detector
ppm	part per million
PSLP	Penniman Shell Loading Plant
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RI	Remedial Investigation
RME	reasonable maximum exposure
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SI	Site Inspection
SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
TNT	trinitrotoluene
TOC	total organic carbon
UCL	upper confidence level
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
WPNSTA	Naval Weapons Station

# Introduction

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This Remedial Investigation (RI) report presents the data and findings obtained from the field activities conducted to characterize the nature and extent of contamination and assess potential risks to human health and the environment at Naval Environmental Restoration Program (ERP) Area of Concern (AOC) 6, Trinitrotoluene (TNT) Graining House Sump and TNT Catch Box Ruins subareas, Naval Weapons Station (WPNSTA) Yorktown, Cheatham Annex (CAX), Williamsburg, Virginia. Due to the geographic proximity of the AOC 6 TNT Graining House Sump and the AOC 6 TNT Catch Box Ruins, these two subareas were investigated together and are herein referred to as the AOC 6 TNT Subareas. This report was prepared for the Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, under the Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012 Contract N62470-11-D-8012, Contract Task Order WE47, for submittal to NAVFAC Mid-Atlantic, the United States Environmental Protection Agency (USEPA) Region III, and the Virginia Department of Environmental Quality (VDEQ). The Navy, USEPA, and VDEQ work jointly as the CAX Tier I Partnering Team.

The RI field activities discussed in this report were conducted in September through October 2013, June 2014, and August 2014. The purpose of the RI was to fill data gaps remaining following earlier investigations, to further characterize the nature and extent of contamination, and to support an assessment of potential environmental and human health risks associated with exposure to contaminants in site media at the AOC 6 TNT Subareas. The field activities were conducted in accordance with the Uniform Federal Policy – Sampling and Analysis Plan (SAP) titled *Tier II Sampling and Analysis Plan, AOC 6 TNT Graining House Sump and TNT Catch Box Ruins Subareas Remedial Investigation, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia* (AOC 6 TNT Subareas SAP) (CH2M HILL, 2013).

## 1.1 Objectives and Approach

The objectives of the RI are to characterize the nature and extent of potential contamination in soil and groundwater and to assess the potential risks posed by this contamination to human health and the environment.

- The activities completed to support the objectives of the RI activities were as follows:
- Collection of surface and subsurface soil samples from the AOC 6 TNT Subareas
- Installation of six shallow monitoring wells at the AOC 6 TNT Subareas
- Completion of a groundwater elevation survey and collection of groundwater samples from all new monitoring wells at the AOC 6 TNT Subareas
- Completion of single-well, hydraulic conductivity (K) "slug" tests in monitoring wells at the AOC 6 TNT Subareas
- Installation of a staff gauge in Penniman Lake to determine the Penniman Lake water surface elevation for comparison to the water table elevation in the surficial aquifer at the AOC 6 TNT Subareas
- Quantitative assessment of the potential human health and ecological risks associated with exposure to contaminated site media, where identified

## 1.2 Site Background

This subsection provides a general summary of background information for CAX and the AOC 6 TNT Subareas, including site descriptions and environmental history.

## 1.2.1 CAX

CAX consists of 2,300 acres of land on the York-James Peninsula, northwest of WPNSTA Yorktown (**Figure 1-1**). CAX was the location of the former Penniman Shell Loading Plant (PSLP), a large powder and shell loading facility operated by DuPont during World War I. The facility closed in 1918, and the property was used for farming or remained idle until CAX was commissioned in 1943 as a satellite unit of the Naval Supply Depot to provide bulk storage facilities and serve as an assembly and overseas shipping point throughout World War II. In 1987, CAX was designated the Hampton Roads Navy Recreational Complex. Today, the mission of CAX includes supplying Atlantic Fleet ships and providing recreational opportunities to military and civilian personnel, with outdoor recreational facilities including cabins, camping sites, an 18-hole golf course, swimming pool, ball fields, freshwater and saltwater fishing areas, boating, wildlife watching, and hunting.

CAX is bordered by Queen Creek to the north, the Colonial National Historical Park to the south, the York River to the east, King Creek to the southeast, and the Queens Lake subdivision to the west; the City of Williamsburg is southwest of CAX. The majority of CAX is undeveloped and heavily wooded. Major surface water features at CAX are Youth Pond, Cheatham Pond, Jones Pond, and Penniman Lake. Potable water supply at CAX is provided by Newport News Waterworks (ASTDR, 2004).

In October 1998, control of CAX was transferred from the Fleet and Industrial Supply Center to WPNSTA Yorktown. Comprehensive environmental restoration (ER) activities at CAX began in 1984 under the Navy Assessment and Control of Installation Pollutants program and the ERP. On January 2, 2001, CAX was added to the National Priorities List, which required all subsequent ER activities to be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Navy, Commonwealth of Virginia (through VDEQ), and USEPA executed a Federal Facilities Agreement in March 2005, which identified a total of 12 Sites and seven AOCs to be addressed under CERCLA (USEPA et al., 2005).

## 1.2.2 AOC 6 TNT Subareas

Five non-contiguous subareas comprise AOC 6, each less than 1 acre in size, and all related to the former PSLP. The PSLP was an explosives manufacturing facility operated during World War I by the E.I. DuPont de Nemours & Company on what is now CAX and adjacent properties. This facility operated as a TNT manufacturing plant beginning in approximately 1916, and subsequently added the loading of artillery shells for the war effort in 1918. Between 1918 and 1925, following the end of the war, this facility was demolished and reverted to farmland or left idle until CAX was commissioned in 1943 as a satellite unit of the Naval Supply Depot to provide bulk storage facilities and serve as an assembly and overseas shipping point throughout World War II.

In August 2000, the USEPA and Navy agreed to investigate five subareas related to the former PSLP (1918 Drum Storage Area, Ammonia Settling Pits, TNT Graining House Sump, TNT Catch Box Ruins, and Waste Slag Material). These subareas comprise AOC 6 (Penniman AOC), and are located within the vicinity of the former shell loading area, south of Sanda Avenue (formerly DuPont's "G" plant) on Navy property (Weston, 1999) (**Figure 1-2**). The AOC 6 TNT Subareas, combined, are approximately 0.5 acre in size and are located along the southwest bank of Penniman Lake (**Figure 1-2**). The AOC 6 TNT Subareas are the only subareas investigated as part of this RI; the other three AOC 6 subareas were evaluated separately.

The history of the AOC 6 TNT Subareas is largely unknown. Roy F. Weston, Inc. (Weston) identified these subareas as potential waste sources through a review of historical aerial photographs, engineering drawings, and site reconnaissance visits (Weston, 1999). The TNT Graining House Sump subarea includes the concrete footprint of the former TNT Graining House as well as the concrete-lined, open top pit believed to be the sump pit for the TNT Graining House. The TNT Catch Box Ruins subarea consists of an earthen, brick-lined depression located immediately east and adjacent to the TNT Graining House. The TNT Catch Box was used to separate TNT particles from wastewater. Potential historical leakage or discharge from the former TNT

Graining House sump and/or TNT Catch Boxes are the sole known or suspected sources of contamination at the AOC 6 TNT Subareas (Figure 1-3).

## 1.3 Summary of Previous Investigations

This section presents a summary of the findings from previous investigations conducted prior to the RI field activities. While the results of the previous investigations are briefly mentioned in this section, only the 2012 Site Inspection (SI) analytical data were combined with the current RI data for evaluation in this report, and are discussed in greater detail in Section 4.

### 1.3.1 AOC 6 TNT Subareas Previous Investigations

Previous investigations that helped characterize potential contamination at the AOC 6 TNT Subareas are the 1999 SI (Weston, 1999) and the 2012 SI (CH2M HILL, 2012).

#### 1.3.1.1 1999 Site Inspection

In January 1999, one waste sample was collected from each of the TNT subareas to assess potential sources of contamination associated with the former PSLP and to support hazard ranking system (HRS) evaluations. The waste samples were analyzed for Target Compound List organic compounds (volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], pesticides, and polychlorinated biphenyls [PCBs]), Target Analyte List inorganic constituents, cyanide, and explosives constituents. The analytical results indicated that detections of one explosive and several inorganic constituents exceeded the 1999 USEPA Region III risk-based concentrations, as summarized in the *Final Site Inspection Narrative Report for the Penniman Shell Loading Plant* (Weston, 1999), and these data were further reviewed as part of the 2012 SI Work Plan (CH2M HILL, 2008).

#### 1.3.1.2 2012 Site Inspection

In 2008, SI field activities were conducted that included surface and subsurface soil sampling, groundwater sample collection via direct-push technology (DPT), and surface water and sediment (surface and subsurface) sampling from nearby Penniman Lake. The soil and sediment samples were analyzed for SVOCs, explosives, inorganic constituents, and cyanide; the groundwater and surface water samples were analyzed for SVOCs, explosives, inorganic constituents (total and dissolved), cyanide (total and dissolved), and hardness (surface water only). Since VOCs, SVOCs, pesticides, and PCBs were not found to be constituents of potential concern (COPCs) during the 1999 SI, these analyses were not carried forward to the 2012 SI, with the exception of SVOCs, which were added at the request of the USEPA. The sampling results were evaluated as part of the SI Report (CH2M HILL, 2012) and indicated that potentially unacceptable human health and/or ecological risks were associated with exposure to explosives and inorganic constituents in soil and inorganic constituents in groundwater; therefore, an RI was recommended. Because no potential human health or ecological risks were identified for sediment and surface water, and since these media are being evaluated as part of the Penniman Lake SI, no further action with respect to the AOC 6 Ammonia Settling Pits and TNT Subareas was recommended for sediment and surface water (CH2M HILL, 2012).

As part of the SI that began in 2008, a geophysical survey was conducted in April 2010 around the AOC 6 Ammonia Settling Pits, TNT Graining House Sump, and TNT Catch Box Ruins subareas to address USEPA's concerns as to whether the buildings in these areas had underground piping connecting them to each other or to other former PSLP buildings for the transfer of explosives materials. The results of the geophysical survey showed no evidence of underground piping at any of the three subareas (CH2M HILL, 2012).

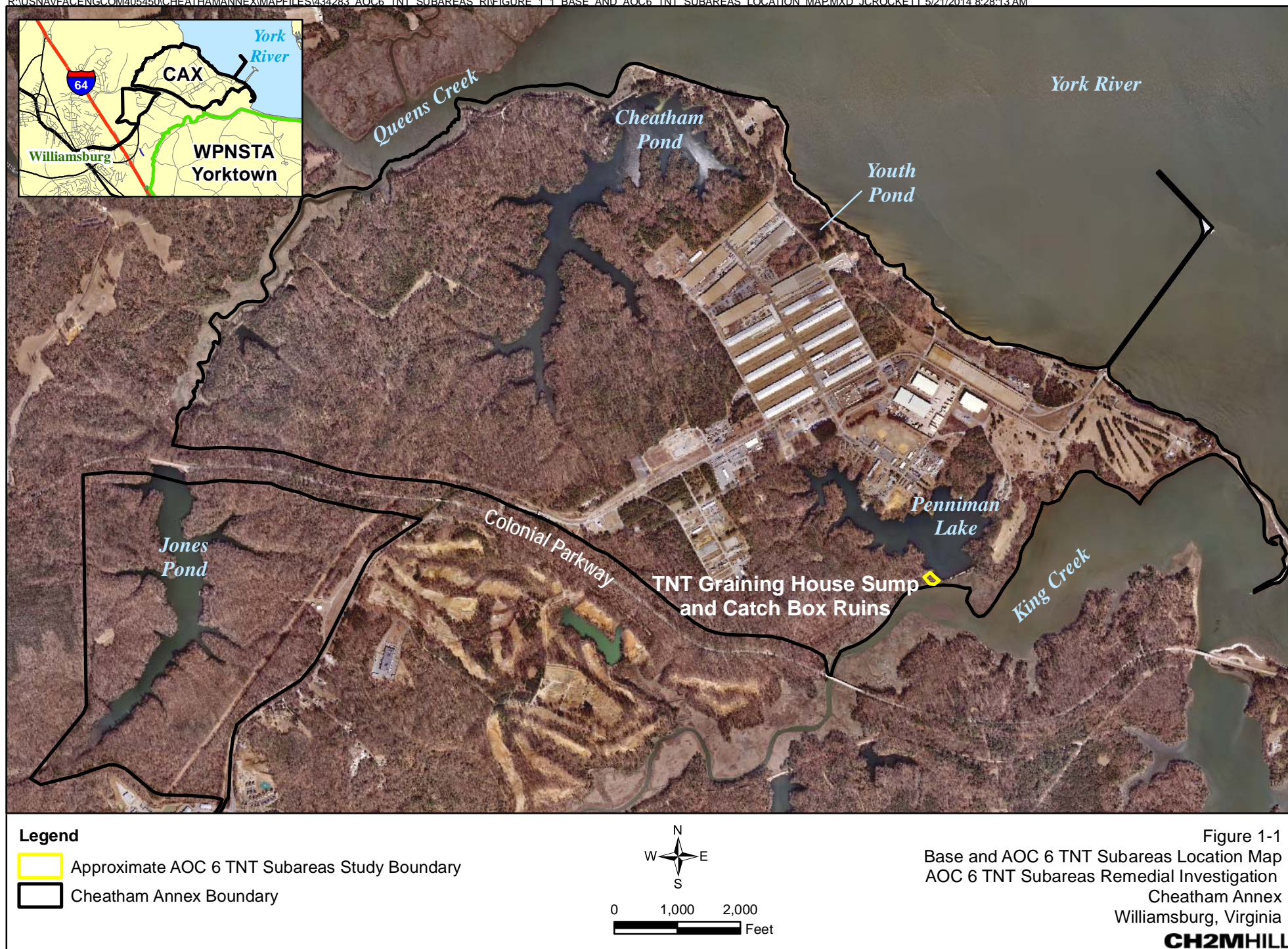
## 1.4 Report Organization

The RI report is organized as follows:

- **Section 1** – Introduction
- **Section 2** – Field Investigation Methods
- **Section 3** – Physical Characteristics

- **Section 4** – Nature and Extent of Contamination
- **Section 5** – Human Health Risk Assessment
- **Section 6** – Ecological Risk Assessment
- **Section 7** – Chemical Fate and Transport
- **Section 8** – Conclusions and Recommendations
- **Section 9** – References

Tables and figures are provided at the end of each respective section. Appendixes are included at the end of the report.





# Legend

- Approximate AOC 6 Subarea Study Boundary
- Approximate AOC 6 TNT Subareas Study Boundary
- CAX Boundary / Fenceline

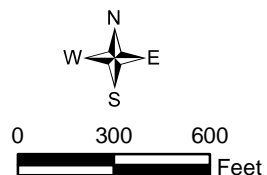


Figure 1-2  
Site Location Map  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia



#### Legend

- Topographic High Point (dashed where approximated)
- Approximate AOC 6 TNT Subareas Study Boundary
- Berm Boundary
- Former TNT Graining House Sump/Former Catch Box Ruins Boundary

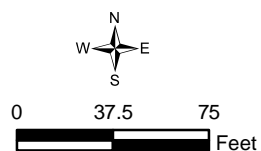


Figure 1-3  
AOC 6 TNT Subareas Vicinity Detail Map  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia

# Field Investigation Methods

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This section describes the approach and methodology for the field activities conducted as part of the RI at the AOC 6 TNT Subareas. Field activities for the AOC 6 TNT Subareas included surface and subsurface soil sampling, monitoring well installation, groundwater monitoring and sampling, K testing, a field inspection of the TNT Graining House Sump, and installation of a staff gauge in Penniman Lake. Specific details of the sampling rationale and objectives for the AOC 6 TNT Subareas field activities are provided in the AOC 6 TNT Subareas SAP (CH2M HILL, 2013).

**Table 2-1** summarizes all of the environmental data that were evaluated during this RI, including the number of samples collected, sample nomenclature, the media sampled, the sample collection methods, and the analyses performed. **Figure 2-1<sup>1</sup>** depicts the locations of all samples collected during the RI in various environmental media.

The investigation activities were implemented to support:

- Development of the hydrogeologic conceptual model for the AOC 6 TNT Subareas (**Section 3**)
- Assessment of the nature, extent, fate, and transport of contamination, potential sources of contamination, and development of a contaminant transport conceptual site model (CSM) (**Sections 4 and 7**, respectively)
- Assessment of potential risks to human health and the environment (**Sections 5 and 6**, respectively)
- Information to be utilized for the potential completion of a future Focused Feasibility Study (FFS) (**Section 8**)

## 2.1 AOC 6 TNT Subareas Field Investigation Activities

### 2.1.1 Pre-Investigation Activities

Prior to the RI field activities, underground utility clearance was conducted at the AOC 6 TNT Subareas on September 12, 2013, by Accumark, Inc., of Ashland, Virginia.

In addition, vegetation clearance was conducted on September 17, 2013, by Parratt-Wolff of East Syracuse, New York, utilizing a Terex skid-steer loader.

### 2.1.2 Soil Sampling

Surface (0 to 6 inches below ground surface [bgs]) and subsurface (6 to 24 inches bgs) soil samples were collected to better define the extent of soil contamination and evaluate potential risks associated with exposure to soil at the AOC 6 TNT Subareas. The soil samples were divided into three groups:

- Surface and subsurface soil samples collected in the vicinity of the AOC 6 TNT Subareas to provide expanded spatial coverage to adequately characterize this medium
- Surface and subsurface soil samples collected from areas where elevated chromium concentrations were detected during the 2012 SI

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<sup>1</sup> The “berm boundary” on Figure 2-1 represents the remnants of an earthen berm that was installed during construction of the former PSLP and assumed to provide some protection should an explosion occur. Berms [or “bunkers” as they are referred to on historic drawings (Weston, 1999)] were constructed of various configurations (either completely surrounding or horseshoe- or L- shaped) around several of the former PSLP buildings where an unexpected detonation of explosive materials could occur. The berm is located outside of the footprint of the TNT Subareas; therefore, no sampling of this area is necessary.

- Three-point composite surface and subsurface soil samples collected from the surface depression at the AOC 6 TNT Catch Box Ruins to account for the potential variability of contaminant concentrations within this area and to address the potential for contamination above the water table

The soil sampling activities were conducted in accordance with the Standard Operating Procedure (SOP) entitled *Shallow Soil Sampling* (CH2M HILL, 2013). Surface soil samples, collected with a hand auger, were obtained from a depth of 0 to 6 inches bgs while subsurface soil samples, also collected with a hand auger, were obtained from a depth of 6 to 24 inches bgs, as outlined in the approved AOC 6 TNT Subareas SAP. Following sample collection, organic vapors emanating from each soil sample were monitored with a photoionization detector (PID). Any responses from the PID were noted in the field logbook; no soil samples registered a PID reading above 0.00 part per million.

#### 2.1.2.1 Soil Sampling in the vicinity of the AOC 6 TNT Subareas

Co-located surface and subsurface soil samples were collected from 12 locations (**Figure 2-1** – sample locations CAA06-SO28 through CAA06-SO39) surrounding the AOC 6 TNT Graining House Sump and AOC 6 TNT Catch Box Ruins to supplement the 2012 SI data in order to determine the extent of soil contamination and evaluate potential risks to human health and the environment. Thirteen sample locations were initially proposed in the AOC 6 TNT Subareas SAP. However, based on the actual site conditions, the CAX Partnering Team verbally agreed on September 12, 2013, to eliminate one of the proposed locations since the existing berm prohibited sampling native soil in the intended area. In addition, the remaining RI soil samples, plus soil samples from the 2012 SI, provide adequate soil sample coverage to the north, west, and east of the AOC 6 TNT Subareas (which is limited in size). The CAX Partnering Team agreed to re-locate soil sample location CAA06-SO28 to the southwest in order to collect a representative sample of native soil since its proposed location, at the time, had standing water from a rain event.

In accordance with the approved AOC 6 TNT Subareas SAP, soil samples were analyzed for explosives, 2,4-dinitrotoluene<sup>2</sup>(DNT), inorganic constituents, total organic carbon (TOC), pH, and grain size (surface soil samples only) (**Table 2-1**). After collection in sampling containers, the samples were packed on ice and shipped to the laboratory (TriMatrix Laboratories of Grand Rapids, Michigan) for analyses, in accordance with the SOP entitled *Packaging and Shipping Procedures for Low-Concentration Samples* (CH2M HILL, 2013).

#### 2.1.2.2 Hexavalent Chromium Sampling

Two co-located surface and subsurface soil samples (CAA06-SS/SB26 and CAA06-SS/SB27) were collected from those locations where elevated chromium concentrations were detected during the 2012 SI (CAA06-SO03 and CAA06-SO01, respectively) in order to refine the Human Health Risk Assessment (HHRA) for the AOC 6 TNT Subareas by determining the ratio of trivalent chromium to the more toxic hexavalent chromium. In accordance with the approved AOC 6 TNT Subareas SAP (CH2M HILL, 2013), these soil samples were analyzed for total and hexavalent chromium (**Table 2-1**). After collection in sampling containers, the samples were packed on ice and shipped to the laboratory (Columbia Analytical Services of Rochester, New York) for analyses, in accordance with the SOP entitled *Packaging and Shipping Procedures for Low-Concentration Samples* (CH2M HILL, 2013).

#### 2.1.2.3 Three-point Composite Soil Sampling at the AOC 6 TNT Catch Box Ruins

Co-located surface and subsurface, three-point composite soil samples (CAA06-SO26-000H [0 to 6 inches bgs] and CAA06-SO26-0H02 [6 to 24 inches bgs]) were collected from the lowest portion and center of the AOC 6 TNT Catch Box Ruins. The center of the three collection points was within the vicinity of the 2012 SI location CAA06-SO01, where the highest detections of explosives and inorganic constituents were observed

<sup>2</sup> Since 2,4-DNT was the only SVOC constituent detected in soil during the 2012 SI, the RI soil samples were submitted for analysis of 2,4-DNT. However, the laboratory method for analyzing this constituent also provided results for 2,6-DNT and nitrobenzene.

in surface and subsurface soil; the two other collection points were located 18 inches to the north and south of the center collection point.

In accordance with the approved AOC 6 TNT Subareas SAP (CH2M HILL, 2013), the three-point composite soil samples were analyzed for 2,4-DNT<sup>1</sup>, explosives, inorganic constituents, TOC, pH, and grain size (three-point composite surface soil sample only) (**Table 2-1**). After collection in sampling containers, the samples were packed on ice and shipped to the laboratory (TriMatrix Laboratories of Grand Rapids, Michigan) for analysis, in accordance with the SOP entitled *Packaging and Shipping Procedures for Low-Concentration Samples* (CH2M HILL, 2013).

## 2.1.3 Groundwater Sampling

### 2.1.3.1 Monitoring Well Installation

Six shallow monitoring wells (CAA06-MW01 through CAA06-MW06) were installed within the Columbia (surficial) aquifer to depths up to 20 feet bgs (**Figure 2-1**). Each monitoring well was installed in accordance with the SOP entitled *General Guidance for Monitoring Well Installation* (CH2M HILL, 2013). The monitoring well construction details are summarized in **Appendix A**.

Parratt-Wolff, Inc., of Hillsborough, North Carolina, provided hollow-stem auger (HSA) well drilling and installation services using a 4.25-inch-inside-diameter (ID) HSA. During the lithologic logging of soil cores (collected using 4-foot-long Macro Core sampler), soil descriptions, including grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination, were recorded. Soil boring logs are included in **Appendix A**.

New monitoring wells were constructed with flush-threaded, 2-inch-ID Schedule 40 polyvinyl chloride (PVC) casing and well screen (**Appendix A**). In accordance with the SOP entitled *Installation of Shallow Monitoring Wells* (CH2M HILL, 2013), the well screens were 10 feet long with 0.010-inch slot sizes. A silica sand filter pack was placed around the annular space of the well screen from the bottom of the boring and well screen to a depth of approximately 2 feet above the top of the screen. A bentonite layer (approximately 1 to 2 feet) was placed at the top of the sand pack. After the bentonite was allowed to hydrate for at least 24 hours, a cement-bentonite grout was placed in the remaining annular space to the surface. All monitoring wells were completed with steel stick-up protective casings and surrounded by four protective bollards. A locking, watertight cap was placed on the top of each casing, and the well identification numbers were clearly marked on the well with etched well identification tags.

### 2.1.3.2 Monitoring Well Development

Prior to sampling, all monitoring wells were developed in order to restore the permeability of the aquifer material surrounding the well, which may have been reduced by the drilling operations, and to remove fine-grained materials that may have entered the well during installation. Monitoring well development was performed after the grout used to construct the new monitoring wells was allowed to adequately set (at least 24 hours or more) to prevent grout contamination of the screened interval. Monitoring wells were developed using a submersible pump and a combination of surging and pumping throughout the well screen.

Between 18 and 40 gallons of water were evacuated from each well, with a total of 182 gallons of water purged during the entire monitoring well development event. During monitoring well development, in accordance with the SOP entitled *Installation of Shallow Monitoring Wells* (CH2M HILL, 2013), water quality parameters (pH, oxidation-reduction potential [ORP], temperature, conductivity, turbidity, and dissolved oxygen [DO]) were recorded approximately every 5 minutes using a YSI water-quality meter. The YSI instrument was calibrated daily, and calibration results were recorded in the field notebook.

Generally, development continued until at least three well volumes were removed and the water produced was free of turbidity, sand, and silt (to the maximum extent practicable) or the monitoring well was purged dry. A YSI water-quality meter was used to determine when the turbidity was low (preferably less than 20 Nephelometric Turbidity Units). If turbidity continued to decrease after the removal of three well volumes,

development was continued until turbidity readings stabilized (that is, until turbidity readings were within 10 percent of each other for three consecutive readings). In addition, development typically ended once three successive measurements of pH, specific conductivity, and temperature within 10 percent of each other were achieved.

### 2.1.3.3 Groundwater Elevation Measurements and Installation and Survey of Staff Gauge in Penniman Lake

A groundwater elevation survey was conducted at all six monitoring wells prior to sampling on October 2, 2013, and additional rounds of groundwater elevation measurements were collected on June 18, 2014, and August 22, 2014. An electronic water-level meter was used to measure the depth to water from the marking on the top of casing to the nearest 0.01 foot.

To determine the potential for Penniman Lake to be recharging groundwater in the surficial aquifer at the AOC 6 TNT Subareas and influencing groundwater flow directions, a staff gauge was installed on August 22, 2014, near the overflow inlet near Penniman Lake dam (**Figure 2-1**). Immediately following the staff gauge installation, the staff gauge was surveyed by ECLS of Angier, North Carolina (a Virginia-licensed and registered surveyor), and an additional round of groundwater level measurements was collected from each of the six monitoring wells in the AOC 6 TNT Subareas. **Table 2-2** summarizes the water-level measurements from each round of groundwater measurements at the CAX AOC 6 TNT Subareas monitoring wells, as well as the measured surface water elevation at the Penniman Lake staff gauge (PL-SG01).

### 2.1.3.4 Groundwater Sampling

Groundwater samples were collected from all monitoring wells in accordance with the SOP entitled *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III* (CH2M HILL, 2013) in order to minimize drawdown and to obtain samples representative of groundwater conditions in the surrounding geologic formation. Prior to groundwater sample collection, monitoring wells were purged in order to remove any stagnant water that may have accumulated within the well. Groundwater samples were collected from monitoring wells using a peristaltic pump and disposable tubing. Groundwater quality parameters comprising pH, conductivity, turbidity, DO, temperature, and ORP were measured during the purging of each well using a YSI water-quality meter and a flow-through cell to prevent the purged groundwater from contacting the atmosphere during parameter measurement.

Purging continued until water quality readings collected five minutes apart stabilized to within 10 percent of one another. Following parameter stabilization, CHEMet test kits were used to confirm DO readings measured by the YSI water-quality meters (both Model Number 600XLM), as well as to measure ferrous iron concentrations. Once DO reading confirmation was obtained, the flow-through cell was disconnected and samples were collected directly into laboratory-prepared, pre-preserved sample bottles. The final set of groundwater quality measurements recorded before sample collection for each monitoring well is presented in **Table 2-3**.

Groundwater samples were analyzed for total and dissolved inorganic constituents and natural attenuation parameters comprising alkalinity, chloride, methane, nitrate, nitrite, pH, sulfate, sulfide, and TOC. Groundwater for the analytical samples was pumped through tubing directly into the appropriate laboratory-provided bottleware, with the exception of samples to be analyzed for dissolved inorganic constituents. Groundwater collected for dissolved inorganic constituents analysis was pumped through a 0.45-micrometer filter and then directly into the sample bottleware. After collection in sampling containers, and at the end of each day, the samples were packed on ice and shipped via overnight service to the laboratory for analysis in accordance with the SOP entitled *Packaging and Shipping Procedures for Low-Concentration Samples* (CH2M HILL, 2013).

### 2.1.3.5 Hydraulic Conductivity Testing

Aquifer K at the site was evaluated using single-well K tests, commonly referred to as “slug tests.” Due to the limited area of influence achieved during a test, the slug test data provide a rough estimate of the

hydrogeologic parameters of the aquifer unit proximal to the individual monitoring wells. The slug tests were conducted in the following steps:

**Static Water-Level Measurement:** The static (pre-test) water level in the well was measured using an electronic water-level meter with a graduated tape.

**Pressure Transducer Placement:** A pressure transducer was set 1 foot above the bottom of each well. The pressure transducer was secured to the well to minimize disturbance during testing. The pressure transducer was connected to a data logger programmed to collect a water-level measurement every second for the duration of the test.

**Falling Head Test:** A slug (consisting of a 5.3-foot-long, 1.5-inch-diameter cylinder made of solid plastic) was lowered until the base of the slug was near the top of the water, and then dropped into the water, causing displacement of water in the well, which was manifested by an almost instantaneous rise in the water level within the well. The water level in the well was monitored as it equilibrated by the pressure transducer and manual measurements until the water level within the well returned at least 90 percent of the way to the originally measured static water level.

**Rising Head Test:** After the falling head test was completed, the slug was quickly removed from the well, causing an almost instantaneous drop in the water level. The water level in the well was monitored as it equilibrated by the pressure transducer and manual measurements until the water level returned at least 90 percent of the way to the originally measured static water level.

Tests were conducted on October 4, 2013, in all permanent monitoring wells to provide data across the aquifers at the site and to generate estimates of the K of the aquifer.

### 2.1.3.6 Surveying

The surveyor, ECLS of Angier, North Carolina (a Virginia-licensed and registered surveyor), conducted a survey of the new monitoring wells and the soil sample locations. Each of the monitoring wells was surveyed for vertical and horizontal control to an accuracy of  $\pm 0.01$  foot and  $\pm 0.1$  foot, respectively (**Appendix B**). Monitoring wells were surveyed at the top of the PVC casing (where marked) and at the ground surface. The vertical elevations were referenced to National Geodetic Vertical Datum 88 to remain consistent with the existing CAX vertical datum. Horizontal coordinates conformed to North American Datum 83 with ties to the Virginia State Plane Coordinate System. The survey also included the footprint of the former TNT Graining House and Sump, the TNT Catch Box Ruins, and the maximum elevation of the berm directly north of the former TNT Graining House, as shown in the survey exhibit plat in **Appendix B**.

### 2.1.4 TNT Graining House Sump Field Inspection

On September 19, 2013, the former TNT Graining House sump, located within the footprint of the TNT Graining House (**Figure 1-3**), was inspected. The concrete sump compartment measured 8 feet long, 2.5 feet wide, and 3.6 feet in depth, and water was observed at 2.2 feet above the bottom of the sump. Leaves, roots, and less than two inches of organic material, plus flakes of scraped concrete, were recovered via a three-inch auger bucket, but no residual material from the former ordnance plant processes was present. Therefore, per the AOC 6 TNT Subareas SAP (CH2M HILL, 2013), no residual material sample was collected.

## 2.2 Quality Assurance and Quality Control

Samples collected for the RI were analyzed using SW-846 Program methods with Level IV quality assurance (QA)/quality control (QC), as identified in the AOC 6 TNT Subareas SAP (CH2M HILL, 2013). For definitive data, sample results were reported by the laboratories with the equivalent of USEPA Contract Laboratory Program Level IV QA/QC.

Field QA/QC samples were collected during the sampling program. These samples were obtained to:

- Ensure that disposable and reusable sampling equipment were free of contaminants
- Evaluate field methodology

- Establish ambient field background conditions
- Evaluate whether cross-contamination occurred during sampling and/or shipping

Several types of field QA/QC samples were collected and analyzed in accordance with the AOC 6 TNT Subareas SAP (CH2M HILL, 2013). They are defined as follows:

- **Equipment Rinsate Blank (decontaminated equipment):** Equipment blanks were collected at the frequency noted in Section 2.4 or Worksheet #12 of the AOC 6 TNT Subareas SAP (one per medium per day of sampling). These samples were obtained by running laboratory-grade deionized (DI) water over or through sample collection equipment after the equipment was decontaminated. These samples were used to determine whether decontamination procedures for reusable equipment were adequate.
- **Equipment Rinsate Blank (disposable equipment):** Equipment blanks were collected at the frequency noted in Worksheet #12 of the AOC 6 TNT Subareas SAP (once per lot). These samples were obtained by running laboratory-grade DI water over or through sample collection equipment prior to the equipment's use. These samples were used to determine whether disposable, one-time-use equipment was contaminant-free prior to use.
- **Duplicate Sample:** Duplicate samples were collected at the same time and under identical conditions as their respective associated sample, at the frequency noted in Section 2.4 or Worksheet #12 of the AOC 6 TNT Subareas SAP (one per 10 field samples of similar matrix). These samples were collected to evaluate the field and laboratory reproducibility of sample results, and are one way to evaluate field methodology.

In addition to samples collected to monitor field QC, samples were also collected to monitor quality within the laboratory. These included the following:

- **Matrix Spike (MS):** An aliquot of a matrix (that is, soil, groundwater, and so forth) was spiked with known quantities of analytes of interest and subjected to the entire analytical procedure. By measuring the recovery of these spiked quantities, the appropriateness of the method for the matrix was demonstrated.
- **Matrix Spike Duplicate (MSD):** These samples were collected as second aliquots of the same matrix as the MS to determine the precision of the method.

One MS sample and one MSD sample were collected for every 20 environmental samples collected (or greater than or equal to 5 percent of the samples collected) per medium.

## 2.3 Decontamination Procedures

All decontamination activities were conducted in accordance with the SOPs entitled *Decontamination of Personnel and Equipment* and *Decontamination of Drilling Rigs and Equipment*, as applicable (CH2M HILL, 2013). Disposable sampling equipment and personal protective equipment, such as Masterflex tubing and nitrile gloves, were not decontaminated after use and instead were disposed as non-hazardous solid waste. After use, disposable equipment was placed in plastic contractor bags and disposed in an onsite trash dumpster. Non-disposable sampling equipment, such as hand augers, was decontaminated prior to each use.

Reusable, heavy equipment, such as drilling rods and augers, was decontaminated before and in between the collection of each sample using a high-pressure steam cleaner with potable-grade water. Pressure-washing was conducted at the temporary decontamination pad, which had been constructed prior to the start of drilling activities. The decontamination pad consisted of a raised wood frame lined with a high-density polyethylene tarp, which acted as a basin to collect fluids. These fluids were then pumped into approved 55-gallon drums to await characterization and disposal. All heavy equipment decontamination procedures were conducted in accordance with the SOP entitled *Decontamination of Drilling Rigs and Equipment* (CH2M HILL, 2013).

Water generated during decontamination of sampling equipment was collected and transferred to an approved 55-gallon drum to await characterization and disposal.

## 2.4 Investigation-derived Waste Management

Investigation-derived waste (IDW) generated during the AOC 6 TNT Subareas RI included soil cuttings, well development groundwater, groundwater sampling purge-water, as well as decontamination rinse-water from all non-disposable sampling equipment and heavy equipment. The IDW was containerized in approved 55-gallon drums that were properly labeled and stored on secondary containment at ER Site 7, the approved IDW staging location. In total, eight drums of solid IDW and eight drums of aqueous IDW were generated during the AOC 6 TNT Subareas RI field activities.

Prior to disposal, CH2M HILL field staff collected one composite sample from all aqueous IDW drums and one composite sample from all solid IDW drums. The IDW samples were analyzed for full Toxicity Characteristic Leachate Procedure analyses (VOCs, SVOCs, pesticides, and inorganic constituents), ignitability, reactive cyanide, reactive sulfide, and corrosivity. Based on the analytical results, all IDW was identified as non-hazardous and disposed by Clearfield, MMG, at the company's approved disposal facility located in Chesapeake, Virginia, within 90 days of generation.

All IDW management activities were conducted in accordance with Section 3.2.1 of the AOC 6 TNT Subareas SAP. An analytical summary for the IDW samples is provided in **Table 2-4**. Laboratory analytical data for the IDW samples are presented in **Appendix C**. All IDW handling and disposal information is included in **Appendix D**.

## 2.5 Data Quality Evaluation

The data quality evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with an independent review by a third-party validator, and ends with an overall review by the CH2M HILL project chemistry team. The results of the data quality evaluation are included as **Appendix E**.

TABLE 2-1  
Comprehensive Sample Summary Table  
AOC 6 TNT Subareas Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Sample Identification	Investigation	Matrix	Sample Interval (bgs)	SVOCs	Explosives (including nitroglycerin and nitroguanadine)	Explosives (including nitroglycerin)	Inorganic constituents (including cyanide) <sup>2</sup>	Total and Hexavalent Chromium	TOC	pH	Hardness	Grain size	AVS/ SEM	Alkalinity, Chloride, Methane, Nitrate, Nitrite, Sulfate, Sulfide	Sample Collection Method
CAA06-SS01-1008	2008 CAX AOCs SI	Surface Soil	0-6 inches	X	X		X		X	X					Hand Auger
CAA06-SS02-1008				X	X		X		X	X					
CAA06-SS03-1008				X	X		X		X	X					
CAA06-SS04-1008				X	X		X		X	X					
CAA06-SS07-1108				X	X		X		X	X					
CAA06-SS08-1108				X	X		X		X	X					
CAA06-SS13-1108				X	X		X		X	X					
CAA06-SB01-1008		Subsurface Soil	6-24 inches	X	X		X		X	X					
CAA06-SB02-1008				X	X		X		X	X					
CAA06-SB03-1008				X	X		X		X	X					
CAA06-SB04-1008				X	X		X		X	X					
CAA06-SB07-1108				X	X		X		X	X					
CAA06-SB08-1108				X	X		X		X	X					
CAA06-SB13-1108				X	X		X		X	X					
CAA06-DW01-1108		Groundwater	10-14 feet	X	X		X								Peristaltic Pump
CAA06-DW06-1108			8-12 feet	X	X		X								
CAA06-DW07-1108			9-13 feet	X	X		X								
CAA06-DW08-1108			9.5-13.5 feet	X	X		X								
CAA06-SW01-1008		Surface Water	NA	X	X		X				X				Clean Glass Amber Bottle
CAA06-SW01P-1008 <sup>1</sup>		Sediment	0-0.33 foot	X	X		X		X	X		X	X		Sediment Core Sampler
CAA06-SD01P-1008 <sup>1</sup>															Sediment Core Sampler
CAA06-SSD01-1008		Subsurface Sediment	0.33-0.66 foot	X	X		X		X	X		X	X		
CAA06-SS34-0913	2013 CAX AOC 6 TNT Subareas RI	Surface Soil	0-6 inches	X <sup>3</sup>		X	X		X	X		X			Hand Auger
CAA06-SS35-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS35P-0913 <sup>1</sup>				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS36-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS37-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS38-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS26-0913								X							
CAA06-SS26P-0913 <sup>1</sup>								X							
CAA06-SS27-0913															
CAA06-SS28-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS29-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS30-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS31-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS32-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS33-0913				X <sup>3</sup>		X	X		X	X		X			
CAA06-SS39-0913				X <sup>3</sup>		X	X		X	X		X			

TABLE 2-1  
Comprehensive Sample Summary Table  
AOC 6 TNT Subareas Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Sample Identification	Investigation	Matrix	Sample Interval (bgs)	SVOCs	Explosives (including nitroglycerin and nitroguanadine)	Explosives (including nitroglycerin)	Inorganic constituents (including cyanide) <sup>2</sup>	Total and Hexavalent Chromium	TOC	pH	Hardness	Grain size	AVS/ SEM	Alkalinity, Chloride, Methane, Nitrate, Nitrite, Sulfate, Sulfide	Sample Collection Method		
CAA06-SB26-OH02-0913	2013 CAX AOC 6 TNT Subareas RI	Subsurface Soil	6-24 inches					X							Hand Auger		
CAA06-SB26P-OH02-0913 <sup>1</sup>																	
CAA06-SB27-OH02-0913									X								
CAA06-SB28-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB29-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB30-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB31-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB32-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB33-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB39-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB34-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SB35-OH02-0913				X <sup>3</sup>		X	X		X	X	X	X					
CAA06-SB35P-OH02-0913 <sup>1</sup>				X <sup>3</sup>													
CAA06-SB36-OH02-0913				X <sup>3</sup>													
CAA06-SB37-OH02-0913				X <sup>3</sup>													
CAA06-SB38-OH02-0913				X <sup>3</sup>		X	X		X	X							
CAA06-SO26-000H-0913		3-point Composite Soil	0-6 inches	X <sup>3</sup>		X	X		X	X			X			Hand Auger	
CAA06-SO26-OH02-0913			6-24 inches	X <sup>3</sup>		X	X		X	X							
CAA06-GW01-1013		Groundwater		4-14 feet				X		X	X				X	Peristaltic Pump	
CAA06-GW01P-1013 <sup>1</sup>				4-14 feet				X		X	X				X		
CAA06-GW02-1013	5-15 feet						X		X	X				X			
CAA06-GW03-1013	10-20 feet						X		X	X				X			
CAA06-GW04-1013	4-14 feet						X		X	X				X			
CAA06-GW05-1013	4-14 feet						X		X	X				X			
CAA06-GW06-1013							X		X	X				X			

Notes:

<sup>1</sup>Duplicate sample

<sup>2</sup>Total and dissolved inorganics included for groundwater samples

<sup>3</sup>Since 2,4-dinitrotoluene was the only SVOC constituent detected in soil during the SI, the RI soil samples were submitted for analysis of 2,4-dinitrotoluene. However, the laboratory method for analyzing this constituent also included 2,6-dinitrotoluene and

NA - Not applicable

SS - surface soil

SB - subsurface soil

SO - 3-point composite soil

GW - groundwater

SD - sediment

SSD - subsurface sediment

bgs - below ground surface

Shading indicates data not evaluated in RI report

TABLE 2-2  
Groundwater and Penniman Lake Surface Water Elevations  
AOC 6 TNT Subareas Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Well ID	Total Well Depth (feet below top of casing)	Well Screen Interval (feet bgs)	Ground Elevation (feet amsl)	Top of Casing Elevation (feet amsl)	October 2, 2013			June 18, 2014			August 22, 2014		
					Depth to Water (feet below TOC)	Depth to Water (feet bgs)	Groundwater Elevation (feet amsl)	Depth to Water (feet below TOC)	Depth to Water (feet bgs)	Groundwater Elevation (feet amsl)	Depth to Water (feet below TOC)	Depth to Water (feet bgs)	Groundwater Elevation (feet amsl)
CAA06-MW01	17.25	4-14	13.83	16.86	9.65	6.62	7.21	9.97	6.94	6.89	10.51	7.48	6.35
CAA06-MW02	17.41	4-14	15.37	18.51	11.53	8.39	6.98	11.95	8.81	6.56	12.43	9.29	6.08
CAA06-MW03	18.19	5-15	11.9	15.01	7.93	4.82	7.08	8.39	5.28	6.62	8.91	5.80	6.10
CAA06-MW04	22.90	10-20	12.91	16.09	11.13	7.95	4.96	11.60	8.42	4.49	11.70	8.52	4.39
CAA06-MW05	17.46	4-14	13.59	16.88	10.42	7.13	6.46	10.89	7.60	5.99	11.21	7.92	5.67
CAA06-MW06	17.45	4-14	14.88	17.95	10.95	7.88	7.00	11.33	8.26	6.62	11.80	8.73	6.15
Staff Gauge ID	Top of Mounting Pole (feet amsl)	Top of Gauge at 4.0 Mark (feet amsl)	8/22/2014 (2:00 pm)										
			Penniman Staff Gauge Reading (feet)	Penniman Lake Surface Water Elevation (feet amsl) <sup>1</sup>									
PL-SG01	13.17	11.34	0.72	8.06									

Notes:  
<sup>1</sup>NAV88 elevation was obtained by adding 7.34' to the reading on the staff gauge  
bgs - below ground surface  
amsl - above mean sea level  
TOC - top of casing

TABLE 2-3

## Groundwater Field Parameter Results

## AOC 6 TNT Subareas Remedial Investigation

## Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02	CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-MW06
Sample ID	CAA06-GW01-1013	CAA06-GW02-1013	CAA06-GW03-1013	CAA06-GW04-1013	CAA06-GW05-1013	CAA06-GW06-1013
Sample Date	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13
Field Parameter						
Dissolved Oxygen (mg/L)	1.32	0	0.41	0.10	0.06	0.02
CHEMets® Dissolved Oxygen (mg/L) <sup>1</sup>	0.1	0	1	0.3	0.1	0
Oxidation Reduction Potential (mV)	-53.0	-117.9	-105.1	-179.1	-112.0	-188.6
pH	6.34	6.33	6.51	6.8	6.56	6.84
Specific Conductivity (mS/cm)	0.231	0.304	0.372	0.448	0.373	0.434
Temperature (°C)	18.91	20.24	21.86	20.5	19.68	19.37
Turbidity (NTU)	0.83	4.92	4.46	3.73	6.62	9.4
CHEMets® Ferrous Iron (mg/L) <sup>1</sup>	1	2.4	2.0	4	1.4	4

## Notes:

<sup>1</sup>DO collected using Oxygen (dissolved) CHEMets® Kit; Ferrous iron collected using Iron (total & ferrous) CHEMets® Kit

°C - Degrees centigrade

mg/L - Milligrams per liter

mS/cm - Milliseimens per centimeter

mV - Millivolts

NTU - Nephelometric turbidity unit

TABLE 2-4

## IDW Analytical Results Summary

## AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

<b>Sample ID</b>	CAA06-IDW100313-AQ	CAA06-IDW100313-SO
<b>Sample Date</b>	10/3/13	10/3/13
<b>Chemical Name</b>		
<b>TCLP Volatile Organic Compounds (MG/L)</b>		
No Detections		
<b>TCLP Semivolatile Organic Compounds (MG/L)</b>		
No Detections		
<b>TCLP Pesticides/Polychlorinated Biphenyls (MG/L)</b>		
No Detections		
<b>TCLP Herbicides (MG/L)</b>		
No Detections		
<b>TCLP Metals (MG/L)</b>		
Barium	0.014 J	0.089 J
<b>Wet Chemistry (MG/KG)</b>		
Cyanide	0.081 J	0.05 U
<b>Reactivity (MG/KG)</b>		
No Detections		
<b>Corrosivity (PH)</b>		
pH	6.9	6.2
<b>Ignitability (DEG/F)</b>		
No Detections		

## Notes:

&gt; - Flashpoint is greater than the value reported, no flashpoint was observed

DEG/F - Degrees Fahrenheit

J - Analyte present. Value may or may not be accurate or precise

MG/KG - Milligrams per kilogram

MG/L - Milligrams per liter

NS - Not sampled











PH - pH units

U - The material was analyzed for, but not detected

Shading indicates detection



# Legend

-  Staff Gauge
-  Groundwater Sample Location
-  Groundwater and Surface/Subsurface Soil Sample Location
-  Surface/Subsurface Soil Sample Location
-  Surface/Subsurface/3-point Composite Soil Sample Location
-  Surface/Subsurface Soil Sample Location (Total and Hexavalent Chromium Analyses only)
-  Topographic High Point (dashed where approximated)
-  Approximate AOC 6 TNT Subareas Study Boundary
-  Berm Boundary
-  Former TNT Graining House Sump/Former Catch Box Ruins Boundary



0 50 100  
Feet

Figure 2-1  
AOC 6 TNT Subareas RI Sample Locations  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia

## Physical Characteristics

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This section presents an evaluation of the AOC 6 TNT Subareas physical characteristics pertaining to the conceptual hydrogeology of the site. The physical settings of CAX and the AOC 6 TNT Subareas, including meteorology, topography, land and groundwater use, hydrogeology, and ecological resources, are summarized in this section. This information provides the basis for the hydrologic and hydrogeologic conceptual model of the AOC 6 TNT Subareas, which in turn is a foundational element of the overall CSM for these sites. A detailed hydrologic and hydrogeologic conceptual model is important to describe the primary mechanisms that control the fate and migration of contaminants. The information concerning the physical characteristics of the AOC 6 TNT Subareas also supports the HHRA and Ecological Risk Assessment (ERA).

### 3.1 Climate

The climate of the Virginia Peninsula is influenced by the moderating effects of the Atlantic Ocean, resulting in mild winters and long, warm summers. High humidity occurs frequently along the coast and less frequently inland. The average relative humidity in mid-afternoon is approximately 60 percent. Humidity is higher at night, and the average humidity at dawn is approximately 80 percent. Ground fog is a frequent weather occurrence in late summer, especially during early morning hours.

Freezing temperatures occur intermittently from October through March. The average monthly temperatures in the area range from approximately 38.8 degrees Fahrenheit (°F) in January to 77.4°F in July (Baker, 2003).

Because of its location near the coastline, the vicinity of CAX is subject to easterly storms throughout late summer and early fall, which cause high tides and coastal flooding. Intense tropical hurricanes occasionally sweep the coast. Winter storms that move along the eastern seaboard are often associated with high winds and precipitation, occasionally in the form of snow, ice pellets, or rain; however, the snow is seldom prolonged or heavy. The average annual precipitation is approximately 44 inches, with the summer months being the wettest and the winter months being the driest (Baker, 2003).

Spring is a period of contrasting weather, particularly during March. Spring and autumn are periods of occasional frost. Summer is warm and humid with occasional showers and afternoon thunderstorms. Autumn is a season of comfortable temperatures (average temperature 60°F to 81°F) and generally pleasant weather (Baker, 2003).

Winds are highly variable in the area of CAX. Prevailing winds are usually from the south-southwest, but north-northeasterly winds are common in some months. Onshore winds predominate during the spring and summer (Baker, 2003).

### 3.2 Topography and Surface Drainage Features

The topography at CAX is characterized by gently rolling terrain dissected by ravines and stream valleys trending predominantly northeastward toward the York River. Ground elevations at CAX vary from sea level along the eastern boundary, which borders the York River, to a maximum elevation of approximately 50 feet above mean sea level (amsl) on a few scattered hills in the western portion of the base. Valleys consisting of 40- to 60-foot ravines with steep slopes (slopes exceeding 1:1) occur along the major creeks draining CAX (Baker, 2003).

CAX is bordered on the west by Cheatham Pond, on the north by the mouth of Queen Creek, on the east by the York River, and on the south by King Creek. In 1943, dams were constructed to create the 108-acre Cheatham Pond from a tributary of Queen Creek, as well as the 43-acre Penniman Lake from a tributary of King Creek. Both creeks are tidally influenced; however, Cheatham Pond and Penniman Lake are not.

Damming a portion of the Cub Creek watershed formed Jones Pond, a 69-acre freshwater, non-tidally-influenced pond enclosed by several wooded ravines and located in the southwestern section of CAX. Numerous small creeks flow through wooded ravines throughout CAX and drain into tidal creeks that join the York River. In most areas, forests extend to the marsh and lake margins. The tributaries of CAX all drain into the York River (Baker, 2003).

The AOC 6 TNT Subareas are wooded and moderately vegetated with shrubs. In general, the topography of the AOC 6 TNT Subareas is gently undulating with a somewhat abrupt topographic descent along the shoreline of Penniman Lake. Surficial runoff from the AOC 6 TNT Subareas flows primarily east toward Penniman Lake and southeast toward King Creek (**Figure 3-1**).

### 3.3 Land Use

CAX is a secure military installation that occupies 2,300 acres. The area encompassing the AOC 6 TNT Subareas is approximately 0.5 acre in size and located within the confines of CAX where access by the general public is restricted. Navy and Department of Defense (DoD) personnel do have access to the AOC 6 TNT Subareas for the pursuit of recreational activities such as jogging, hunting, and fishing. Future land use at the AOC 6 TNT Subareas is not expected to change and will likely continue as wooded/recreational in the foreseeable future.

### 3.4 Water Use

Between approximately 1943 and October 2002, Jones Pond was the drinking water source for CAX (ATSDR, 2004). In addition, groundwater from the Yorktown-Eastover aquifer was historically the drinking water source for older individual homes within the vicinity of CAX and was used as a backup water supply for CAX itself. In 2002, the source of drinking water for CAX switched from Jones Pond to water<sup>3</sup> distributed by the City of Newport News Waterworks (ATSDR, 2004). Therefore, groundwater at CAX is not a current or anticipated future source of drinking water at the installation. Furthermore, drinking water is publically available through the City of Newport News Waterworks to all domestic homes located within the vicinity of CAX. The Commonwealth of Virginia does not employ groundwater use classifications; therefore, groundwater at CAX is considered to be of potential beneficial use. There are no fresh surface water bodies within the vicinity of the AOC 6 TNT Subareas that could feasibly be used as a potable water supply.

### 3.5 Hydrogeology

#### 3.5.1 Geology

CAX is located in the Atlantic Coastal Plain Physiographic Province, which is underlain by multiple layers of unconsolidated sediment of Quaternary, Tertiary, and Cretaceous ages (**Figure 3-2**). The primarily granitic rock formations of the Appalachian Mountains to the west were eroded over millennia and sediment was transported from the mountains by rivers and streams to the coast, building up layers of sediment that fanned out onto the Atlantic continental shelf. Successive sea level rises deposited fluvial estuarine and marine sediment further, building the Coastal Plain. Widely fluctuating sea levels sculpted the Coastal Plain into river terraces of different elevations bounded by scarp features that resulted from shoreline erosion. The Coastal Plain in the vicinity of CAX includes four terraces: Lackey Plain, Croaker Flat, Huntington Flat, and Grafton Plain (from highest to lowest), and three scarps: Kingsmill, Lee Hall, and Camp Peary. As shown on **Figure 3-3**, CAX is located within the Lackey Plain and Croaker Flat terraces, separated by the Camp Peary scarp located along the York River (Brockman et al., 1997), with the AOC 6 TNT Subareas located within the Croaker Flat.

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<sup>3</sup> The Chickahominy River is the primary source of drinking water for the City of Newport News, with groundwater from deep wells in the Lee Hall area serving as a secondary source of water (Newport News Waterworks, 2013)

A total of 10 geologic formations have been identified (Brockman et al., 1997) beneath CAX. The uppermost geologic formations consists of alluvial, colluvial, and marsh deposits composed of silt, sand, and pebbles with some clay. In terms of the overlying soils, the AOC 6 TNT Subareas are located within Soil Association Group 2, one of the four soil association groups identified at CAX during a 1985 soil survey report for CAX prepared by the Soil Conservation Service. Soils in Soil Association Group 2, the Dogue, Pamunkey, and Uchee Association (**Figure 3-4**), were formed on river terraces and are deep, well- to poorly drained soils with clayey and loamy subsoils (Baker, 2003). A more detailed description of the soils within Soil Association Group 2 can be found in the 2003 CAX Background Investigation report (Baker, 2003).

The uppermost subsurface geology in the area of the AOC 6 TNT Subareas consists of the Pleistocene (Quaternary) Shirley formation and the Pliocene (Tertiary) Yorktown formation (Mixon et al., 1989). The Shirley formation is relatively thin, only occurs within topographically higher areas located adjacent to the site, and consists of sand, gravel, silt, clay, and trace amounts of organic material. The uppermost portion of the Yorktown formation (Yorktown confining unit) is defined by Brockman and Richardson (1992) as the silt or clay of the Morgarts Beach Member of the Yorktown formation and consists of clay, clayey silt, sandy clay, or silty clay with or without some shell hash or sand stringers (Brockman et al., 1997). Within the Croaker Flat, the Yorktown confining unit impedes the vertical flow of groundwater between the Columbia (surficial) and Yorktown-Eastover aquifers (Brockman et al., 1997). Soil boring data from both the SI (CH2M HILL, 2012) and the RI (**Appendix A**) indicate that the subsurface lithology at the AOC 6 TNT Subareas consists (in descending order) primarily of a thin layer of topsoil underlain by dark and light colored silty sands that are interlayered with fine clays, which are then underlain by a greenish-grey fat clay.

### 3.5.2 Hydrostratigraphy

Each Coastal Plain geologic unit was grouped into hydrostratigraphic units based upon hydrologic characteristics (Lazniak and Meng, 1988; Brockman et al., 1997). Based upon the hydraulic characteristics of the geologic units present, the uppermost eight (Cobham Bay Member of the Eastover formation through the Tabb formation) of the 10 geologic formations have been identified as the York County Shallow Aquifer System. As shown on **Figure 3-2**, the following five hydrogeologic units make up the York County Shallow Aquifer System at CAX (in descending order):

- Columbia aquifer (consisting of the Windsor through Tabb formations)
- Cornwallis Cave confining unit (consisting of the Bacons Castle formation)
- Cornwallis Cave aquifer (consisting of the upper Moore House Member of the Yorktown formation and the Sedley formation)
- Yorktown confining unit (consisting of the upper Morgarts Beach and lower Moore House Members of the Yorktown formation)
- Yorktown-Eastover aquifer (consisting of the Cobham Bay through Rushmere Members of the Yorktown formation)

Beneath the AOC 6 TNT Subareas, the Camp Peary Scarp truncates portions of the York County Shallow Aquifer System; the Cornwallis Cave Confining Unit and Cornwallis Cave aquifer are not present at this site. The first encountered groundwater occurs within silty sands of the Columbia aquifer that are interlayered with fine clays. The Columbia aquifer is unconfined at the site, approximately 11 to 15 feet thick (**Appendix A**), and is recharged by the infiltration of precipitation. The Yorktown confining unit underlies the Columbia aquifer at the AOC 6 TNT Subareas. Based on a geohydrological study of WPNSTA Yorktown, the Yorktown confining unit is generally 14 feet thick (Brockman et al., 1997).

### 3.5.3 Aquifer Properties

Aquifer “slug” testing was performed at each of the six new AOC 6 TNT Subareas monitoring wells in October 2013 to collect rising-head and falling-head test data to estimate the K of the Columbia aquifer in the vicinity of the wells. The slug test data were analyzed using both the Hvorslev Method (Hvorslev, 1951)

and the Bouwer and Rice Method (Bouwer and Rice, 1976). The K values were reported for both rising- and falling-head methods when the static water-level occurred within the riser pipe portion of the monitoring well (that is, above the screen interval). **Table 3-1** summarizes the results of the testing. The slug test data analyses were performed utilizing AQTESOLV software; the data plots are provided in **Appendix F**, and the average calculated horizontal hydraulic conductivity or Henry's Law Constant ( $K_h$ ) value of 0.962 foot per day (ft/day) is included in **Table F-1** in **Appendix F**. While the Hvorslev solution is generally intended for confined aquifers and the Bouwer-Rice solution is generally intended for unconfined aquifers, a study by Brown et al. (1995) determined that the Hvorslev and Bouwer-Rice solutions are applicable to unconfined and confined aquifers in many cases. Therefore, although the Columbia aquifer is unconfined at the AOC 6 TNT Subareas, the overall maximum and minimum K values calculated from the falling- and rising-head test data were chosen independent of the method used to calculate the K value.

The K values in the Columbia aquifer were estimated to be between 0.130 and 2.234 ft/day. These values fall within or near the reported range of 0.4 to 8 ft/day for this aquifer (Brockman, et. al., 1997).

Slug test results, by their nature, are limited in their ability to accurately estimate the K of an aquifer, in part because of impacts from the filter pack placed around the well during installation. They are generally considered to represent an "order-of-magnitude" level of precision and accuracy in estimating K.

### 3.5.4 Groundwater Flow

The first encountered groundwater at the AOC 6 TNT Subareas is within the Columbia aquifer, and the groundwater elevations on August 22, 2014, ranged from 4.38 feet amsl at CAA06-MW04 to 6.35 feet amsl at CAA06-MW01 (**Table 2-2**). The Penniman Lake surface water elevation at staff gauge PL-SG01 was measured concurrently with the groundwater elevations at the AOC 6 TNT Subareas monitoring wells. The surface water elevation at PL-SG01, at 8.06 amsl, was 1.71 to 3.67 feet above the groundwater elevations, indicating that Penniman Lake is recharging the surficial aquifer at the AOC 6 TNT Subareas and influencing the directions of groundwater flow. The groundwater elevation data indicate that the primary groundwater flow direction at the AOC 6 TNT Subareas is southward, away from Penniman Lake and toward King Creek (**Figure 3-5**).

The average hydraulic gradient (I) along the flow path from CAA06-MW06 to CAA06-MW05 is 0.007<sup>4</sup>. Based on the average calculated K value of 0.962 ft/day within the Columbia aquifer (**Appendix F, Table F-1**), an assumed effective porosity (n) of 0.3<sup>5</sup>, and the average horizontal hydraulic gradient calculated from the groundwater contour map (0.007), the average lateral groundwater velocity<sup>6</sup> at the AOC 6 TNT Subareas is estimated to be 0.022 ft/day.

## 3.6 Ecological Resources

Terrestrial flora at CAX consists predominantly of woodland species (Baker, 2005). The following three types of forest are present:

- Pine stands composed primarily of Loblolly and Virginia pines
- Mixed hardwood stands
- Mixed pine and hardwood stands

Elevated areas are the predominant locations of pine stands, while hardwood stands are found on slopes and in ravines. Native tree species found at CAX include beech, black cherry, red maple, sweet gum, various

<sup>4</sup> Average hydraulic gradient was calculated between monitoring wells CAA06-MW03 and CAA06-MW05, whereby  $I$  (average hydraulic gradient) =  $(6.10 - 5.67 \text{ feet}) / 60 \text{ feet} = 0.007$

<sup>5</sup> Effective porosity of 0.30 used based on analyses of Cenomanian and Albion Age sands (Upper and Middle Potomac aquifer) in the Norfolk, Virginia, area (Brown and Silvey, 1997)

<sup>6</sup> Average groundwater velocity (ft/day) =  $(K \times I) / n$

pinus, white ash, and white oak. The woodland's understory is composed of various seedling trees and vine species, such as Virginia creeper, briars, and honeysuckle. Ferns are found in many moist, shaded areas. Ornamental trees and shrubs have been planted in the improved areas and along major roadways. None of the plant species that occur at CAX are listed on the federal or Commonwealth endangered species lists.

Small, undeveloped tracts of land at CAX support a variety of indigenous wildlife species. Whitetail deer, beaver, skunk, bobcat, red and gray fox, squirrel, raccoon, opossum, and rabbit are present. Game birds, such as wild turkey, quail, duck, and pheasant, are also resident. Songbirds common to the eastern Virginia area are in abundance at CAX, along with a raptor population consisting of small hawks, owls, and osprey. Carrion-feeding birds such as crows and turkey vultures are also common. The southern bald eagle (federally and state protected) is known to nest nearby at WPNSTA Yorktown. Suitable habitat exists for roosting and perching at CAX, but only occasional sightings of eagles have been made there.

Wetlands are mainly found along principal tributaries to the York River and along the York River shoreline at CAX. The following four major marsh types exist along these margins:

- Saltmarsh cordgrass communities
- Big cordgrass communities
- Cattail communities
- Brackish water mixed communities

Freshwater wetlands are also present within the interior, non-tidal areas of the installation. Salinities in the York River estuary bordering CAX can be characterized as mesohaline (from 15 to 20 parts per thousand), and can fluctuate depending on seasonal impacts, runoff, and rainfall. Of the 295 fish species known from the Chesapeake Bay, only 32 are year-round residents. Nursery areas, foraging areas, and spawning ground attract the remaining species from the Atlantic Ocean and freshwater tributaries each year. In the York River, resident fish include hogchoker, weakfish, and oyster toadfish. Spot and croaker are common in nursery and foraging areas in the summer and numerous anadromous and catadromous fish use the area during migration, including the alewife, American eel, American shad, blueback herring, striped bass, and white perch. Commercially and recreationally important species from the York River include American shad, bay anchovy, blue crab, bluefish, croaker, spot, striped bass, summer flounder, and weakfish. The York River in the vicinity of CAX is a designated crab pot fishery from March through November of each year; immediately north of CAX is a spawning and nursery ground for blue crabs. Several species of endangered sea turtles (namely the green, hawksbill, leatherback, loggerhead, and Kemp's Ridley) are known to feed in the Chesapeake Bay and occasionally forage in the York River, including the vicinity of CAX, during the summer.

The York River is designated as Essential Fish Habitat for three species of fish managed by the Mid-Atlantic Fishery Management Council—summer flounder, bluefish, and butterfish. Though both bluefish and butterfish use the more open, pelagic waters characteristic of the river, juvenile summer flounder often use unvegetated, nearshore sandy bottoms and salt marsh creeks as nursery areas. Other species likely to use salt marsh creeks include anchovies, blue crabs, juveniles of migratory species, hard- and soft-shell clams, killifish, minnows, mummichogs, oysters, silversides, and weakfish.

No known federally or state-listed endangered or threatened species are currently using CAX habitats. Suitable habitat exists at CAX for both the red-cockaded woodpecker (federally endangered) and the bald eagle (formerly federally threatened and still protected by the Bald and Golden Eagle Protection Act and state threatened/endangered). Bordering the CAX property is the York River, which provides seasonal habitat for federally and state endangered Kemp's Ridley sea turtles and federally threatened loggerhead sea turtles. The shoreline along the York River may also provide habitat for federally threatened piping plovers. Rare resources and communities identified at CAX in the Virginia Department of Conservation and Recreation Natural Heritage Program database and the CAX Natural Heritage Inventory include a significant great blue heron colony, low salt marsh and salt scrub habitats, coastal plain depression ponds, non-riverine wet hardwood forests, and coastal plain calcareous seepage swamps.

TABLE 3-1

## Slug Test Results

*AOC 6 TNT Subareas Remedial Investigation Report**Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Well ID	Test Type	Hvorslev		Bouwer-Rice	
		K (ft/s)	K (ft/day)	K (ft/s)	K (ft/day)
CAA06-MW01	FH1	1.36E-05	1.173	9.07E-06	0.784
	FH2	9.59E-06	0.829	6.21E-06	0.536
	RH1	1.33E-05	1.153	8.38E-06	0.724
	RH2	1.12E-05	0.967	8.19E-06	0.707
CAA06-MW02	FH1	1.34E-05	1.157	9.18E-06	0.793
	FH2	2.18E-05	1.880	1.46E-05	1.262
	RH1	2.48E-05	2.138	2.04E-05	1.758
	RH2	2.06E-05	1.776	1.28E-05	1.107
CAA06-MW03	FH1	4.56E-06	0.394	3.01E-06	0.260
	FH2	6.47E-06	0.559	5.00E-06	0.432
	RH1	1.91E-06	0.165	1.51E-06	<b>0.130</b>
	RH2	4.47E-06	0.386	2.97E-06	0.257
CAA06-MW04	FH1	2.17E-05	1.873	1.45E-05	1.251
	FH2	1.84E-05	1.589	1.38E-05	1.192
	FH3	9.24E-06	0.798	6.50E-06	0.561
	RH1	8.54E-06	0.738	6.52E-06	0.563
CAA06-MW05	FH1	1.01E-05	0.869	6.36E-06	0.549
	FH2	8.82E-06	0.762	5.62E-06	0.485
	RH1	1.08E-05	0.931	8.33E-06	0.720
	RH2	9.98E-06	0.862	7.10E-06	0.613
CAA06-MW06	FH1	2.59E-05	<b>2.234</b>	2.02E-05	1.744
	FH2	1.52E-05	1.309	1.08E-05	0.937
	RH1	1.25E-05	1.076	8.28E-06	0.715
	RH2	1.67E-05	1.439	1.19E-05	1.032

Note:

**Bold font indicates maximum or minimum  $K_h$  value**



#### Legend

- Topographic High Point (dashed where approximated)
- Elevation Contour Line - 2 ft Interval
- Approximate AOC 6 TNT Subareas Study Boundary
- Berm Boundary
- Former TNT Graining House Sump/Former Catch Box Ruins Boundary

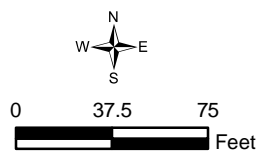
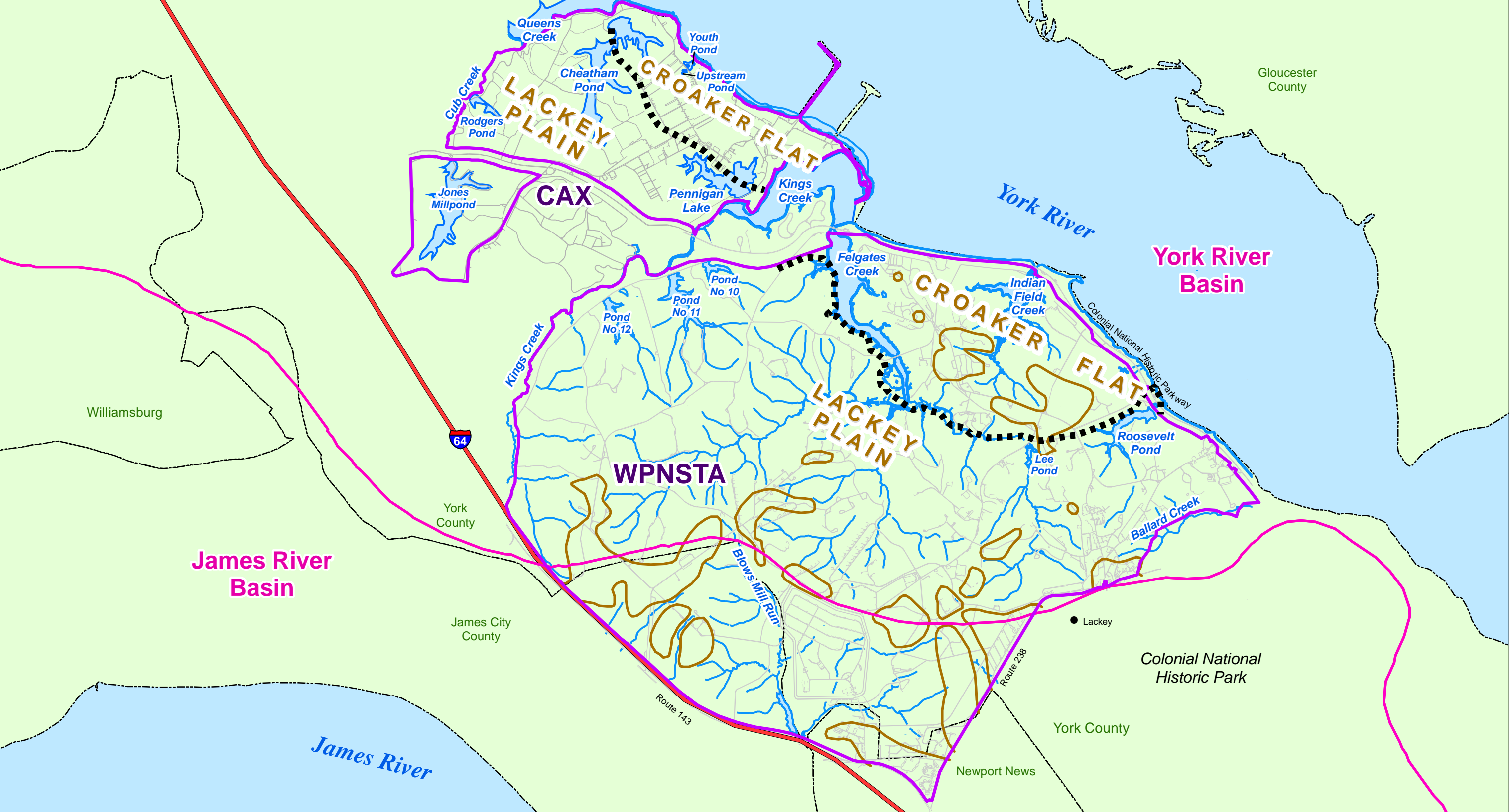


Figure 3-1  
AOC 6 TNT Subareas Topography Map  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia

SYSTEM	SERIES	GEOLOGIC UNIT	HYDROGEOLOGIC UNIT IN THIS REPORT	HYDROGEOLOGIC UNIT
QUATERNARY	HOLOCENE	ALLUVIAL AND MARSH DEPOSITS	COLUMBIA AQUIFER (WHERE UNCONFINED)  CORNWALLIS CAVE CONFINING UNIT  CORNWALLIS CAVE AQUIFER (WHERE CONFINED)  YORKTOWN CONFINING UNIT  YORKTOWN-EASTOVER AQUIFER	LACKEY PLAIN
	PLEISTOCENE	TABB FORMATION		CROAKER FLAT
		SHIRLEY FORMATION		COLUMBIA AQUIFER
		CHUCKATUCK FORMATION		COLUMBIA AQUIFER
		WINDSOR FORMATION		YORKTOWN CONFINING UNIT
TERTIARY	PLIOCENE	BACONS CASTLE FORMATION	YORK COUNTY SHALLOW AQUIFER SYSTEM	CORNWALLIS CAVE CONFINING UNIT
		SEDLEY FORMATION		CORNWALLIS CAVE AQUIFER
		MOORE HOUSE MEMBER		YORKTOWN CONFINING UNIT
		MORGARTS BEACH MEMBER		YORKTOWN CONFINING UNIT
		RUSHMERE MEMBER		YORKTOWN CONFINING UNIT
	MIOCENE	SUNKEN MEADOW MEMBER		YORKTOWN-EASTOVER AQUIFER
		COBHAM BAY MEMBER		EASTOVER-CALVERT CONFINING UNIT
		CLAREMONT MANOR MEMBER		EASTOVER-CALVERT CONFINING UNIT
		ST. MARYS FORMATION		EASTOVER-CALVERT CONFINING UNIT
		CALVERT FORMATION		EASTOVER-CALVERT CONFINING UNIT

Source: Brockman, ET AL 1997 GEOHYDROLOGY OF THE SHALLOW AQUIFER SYSTEM,  
NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA

Figure 3-2  
Hydrogeologic Units in York County/Williamsburg  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia



- Legend**
- Activity Boundaries
  - Camp Peary Scarp
  - Watershed Boundaries
  - Interstate 64
  - Approximate Boundary of Columbia Aquifer, February 3, 1997
  - Roads
  - Shoreline and Water Bodies
  - City / County Boundaries

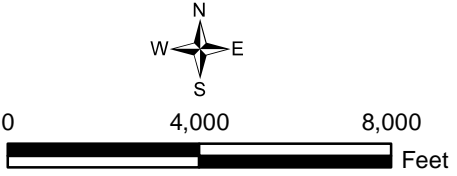
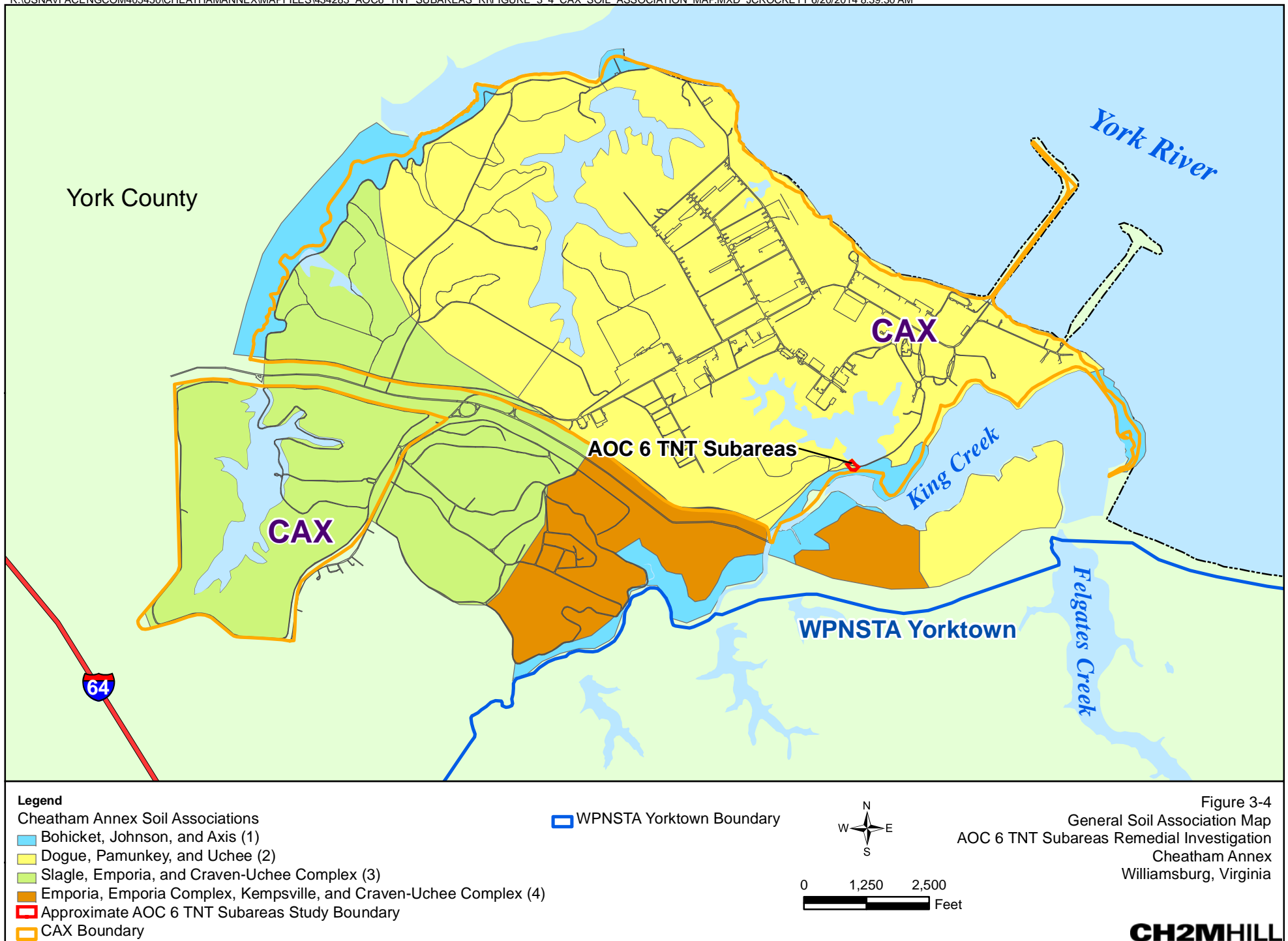


Figure 3-3  
River Terraces of the Atlantic Coastal Plain  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia





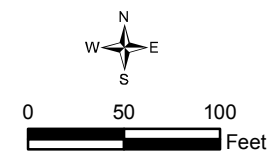
#### Legend

- Staff Gauge
- Groundwater Sample Location
- Groundwater and Surface/Subsurface Soil Sample Location
- Topographic High Point (dashed where approximated)
- Surficial Aquifer Potentiometric Surface Contour (dashed where inferred)
- Approximate Direction of Groundwater Flow
- Approximate AOC 6 TNT Subareas Study Boundary

- Berm Boundary
- Former TNT Graining House Sump/Former Catch Boxes boundary

Notes:  
 4.96 = Groundwater Elevation amsl  
 8.06 = Surface water Elevation amsl

Figure 3-5  
 Surficial Aquifer Potentiometric Surface Contours – August 22, 2014  
 AOC 6 TNT Subareas Remedial Investigation  
 Cheatham Annex  
 Williamsburg, Virginia



## SECTION 4

# Nature and Extent of Contamination

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This section presents an evaluation of the nature and extent of contamination within soil and groundwater at the AOC 6 TNT Subareas. Environmental samples were collected to characterize the vertical and horizontal extents of contamination in order to determine whether remedial action is warranted at these subareas.

The conservative screening values used to evaluate the sampling data at the AOC 6 TNT Subareas are the values presented in the AOC 6 TNT Subareas SAP (CH2M HILL, 2013):

- Soil – USEPA adjusted Residential Soil Regional Screening Levels (RSLs)<sup>7</sup> (USEPA, 2013) and site-specific literature-based ecological screening values (ESVs) for plants and soil invertebrates (if soil is within the first 2 feet of the ground surface)
- Groundwater – USEPA adjusted Tapwater RSLs<sup>8</sup> (USEPA, 2013) and the federal maximum contaminant levels (MCLs)

The background screening values used to evaluate the soil and groundwater sampling data are the surface and subsurface soil background 95 percent upper tolerance limits (UTLs) (CH2M HILL, 2011) and groundwater concentrations from monitoring wells CAA06-MW01 and CAA06-MW06<sup>9</sup>, respectively. Since CAX background concentrations for groundwater are not available for the Columbia aquifer, background/upgradient groundwater quality for CERCLA sites overlying the Columbia aquifer was evaluated on a site-specific basis in accordance with the Final Background Study Work Plan, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia (CH2M HILL, 2009). Monitoring wells CAA06-MW01 and CAA06-MW06 are located upgradient of where historic site activities occurred at the AOC 6 TNT subareas; therefore, the groundwater analytical data from these two monitoring wells best represent groundwater background conditions.

Independent of any comparison to background concentrations, all data that exceed conservative screening values are included in the assessments of potential risks to human health and/or ecological receptors. The quantitative assessments of risks to human health and ecological receptors are included in **Sections 5 and 6** of this report, respectively.

This evaluation includes data collected in 2008 during the recent SI field activities (CH2M HILL, 2012) and this RI. The results from a total of 21 discrete surface soil samples, one three-point composite surface soil sample, 21 discrete subsurface soil samples, one three-point composite subsurface soil sample, and six groundwater samples that were collected from the AOC 6 TNT Subareas were used for this evaluation (**Table 2-1**). Four DPT groundwater samples were also collected during the 2012 SI and the analytical data were used to site the six monitoring wells installed during the RI. However, since the DPT groundwater samples were collected from temporary monitoring wells, the data may not be representative of current groundwater concentrations; consequently, these data were not evaluated in the RI and the monitoring well sampling data were used instead. Additionally, the surface water and sediment data from the 2012 SI (from Penniman Lake) were not evaluated as part of this RI since no potential human health or ecological risks were identified; in addition, these media are being assessed as part of the Penniman Lake SI. Laboratory

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<sup>7</sup> The RSLs for those constituents that pose potential cancer risks were not adjusted, while the RSLs for noncarcinogens were adjusted by dividing by 10 to account for multiple chemicals contributing to potential noncancer risks.

<sup>8</sup> Adjusted to account for exposure to multiple constituents with the same target organ or target effect.

<sup>9</sup> CAX background concentrations for groundwater are not available for the Columbia aquifer; therefore, groundwater concentrations in the site-specific upgradient monitoring wells CAA06-MW01 and CAA06-MW06 were used for comparison purposes during the risk assessments.

analytical results used in this evaluation for the AOC 6 TNT Subareas are summarized by medium and analyte class in **Tables 4-1** through **4-3**. Laboratory analytical reports are included in **Appendix G**.

## 4.1 Soil

A total of 21 discrete and one three-point composite surface soil samples (**Table 4-1**) and 21 discrete and one three-point composite subsurface soil samples (**Table 4-2**) were collected from and around the AOC 6 TNT Subareas during the 2012 SI and the RI and the results evaluated to determine the nature and extent of site-related contamination (**Figure 4-1**):

- Surface and subsurface soil samples collected in the vicinity of the AOC 6 TNT Subareas to provide expanded spatial coverage to adequately characterize this medium
- Surface and subsurface soil samples collected from areas with elevated chromium concentrations during the SI
- three-point composite surface and subsurface soil samples collected from the surface depression at the AOC 6 TNT Catch Box Ruins to account for the potential variability of contaminant concentrations within this area and to address the potential for soil contamination above the water table

During the 2012 SI, soil samples were analyzed for SVOCs, explosive constituents, total inorganic constituents, cyanide, pH and TOC. Based on the results of the SI, soil samples collected during the RI were analyzed only for those constituent groups determined to be potentially site-related based on earlier results (explosive constituents<sup>10</sup> and total inorganic constituents). In addition, the soil samples collected during the RI were analyzed for pH, TOC, and grain size (surface soil samples only) to supplement the ERA, and two discrete, co-located surface and subsurface soil samples were analyzed for total and hexavalent chromium to supplement the HHRA.

### 4.1.1 Organic Compounds

#### 4.1.1.1 SVOCs

The SVOC 2,4-DNT, was detected in surface and subsurface soil within the center of the TNT Catch Box Ruins at a concentration exceeding the adjusted residential RSL; the 2,4-DNT concentration also exceeded the ESV in subsurface soil (**Figure 4-2** and **Figure 4-3**). The 2,4-DNT concentration exceeded the residential RSL (1,600 micrograms per kilogram [ $\mu\text{g}/\text{kg}$ ]) in discrete surface soil sample CAA06-SS01-1008 at an estimated concentration of 6,300  $\mu\text{g}/\text{kg}$  in 2008. However, it was not detected in the three-point composite surface soil sample (CAA06-SO26-000H-0913) collected from the center area of the TNT Catch Box Ruins during the RI. The concentration of 2,4-DNT at the center of the TNT Catch Box Ruins exceeded the adjusted residential RSL during the 2012 SI in discrete subsurface soil sample CAA06-SB01-1008 (1,700  $\mu\text{g}/\text{kg}$ ) and the adjusted residential RSL and ESV during the RI in the three-point composite subsurface soil sample CAA06-SO26-0H02-0913 (12,000  $\mu\text{g}/\text{kg}$ ).

The 2,4-DNT constituent is a synthetic substance used in the production of TNT (ATSDR, 2013). Since the TNT Catch Box was used to separate TNT particles from wastewater, the 2,4-DNT detection is a CERCLA-regulated release likely attributable to historical activities at this subarea. The three-point composite subsurface soil sample CAA06-SO26-0H02-0913 was collected at the center of the TNT Catch Box Ruins and at two locations 18 inches from the center point, as well as directly above the water table. Since 2,4-DNT was not detected at concentrations exceeding screening criteria in any other subsurface soil samples, the horizontal and vertical extents of 2,4-DNT contamination in soil have been delineated at the AOC 6 TNT Subareas.

<sup>10</sup> The constituent 2,4-DNT was the only SVOC that exceeded risk screening criteria in the 2012 SI soil samples and the exceedances occurred at only one sample location (CAA06-SO01). It was included as a constituent in the explosives analysis during the RI. However, to maintain consistency during reporting, the 2,4-DNT analytical results are listed under the SVOC compounds in Tables 4-1 and 4-2 since this is where this compound was listed during the recent SI.

#### 4.1.1.2 Explosive Constituents

Five explosive constituents in surface soil and three explosive constituents in subsurface soil were detected at the AOC 6 TNT Subareas at concentrations exceeding their respective adjusted residential soil RSL, and in some samples, also the ESV (**Figure 4-2 and Figure 4-3**).

- In surface soil, the concentrations of 1,3-dinitrobenzene, 2,4,6-trinitrotoluene (TNT), 2-amino-4,6-DNT, 2-nitrotoluene, and 4-amino-2,6-DNT exceeded the adjusted residential RSL in at least seven samples, and TNT concentrations exceeded the ESV in at least six samples.
  - The maximum-detected concentrations of 1,3-dinitrobenzene (2,500 µg/kg) and TNT (14,000,000 µg/kg) were detected in the three-point composite sample CAA06-SO26-000H-0913; the maximum-detected concentrations of 2-amino-4,6-DNT (16,000 µg/kg), 2-nitrotoluene (48,000 µg/kg), and 4-amino-2,6-DNT (17,000 µg/kg) were detected in sample CAA06-SS02-1008.
- In subsurface soil, the concentrations of 1,3-dinitrobenzene, TNT, and 4-amino-2,6-DNT exceeded the adjusted residential RSL in at least six samples, and TNT concentrations exceeded the ESV in at least five samples.
  - The maximum-detected concentrations of TNT (9,300,000 µg/kg), 1,3-dinitrobenzene (1,600 µg/kg), and 4-amino-2,6-DNT (30,000 µg/kg) were detected in samples CAA06-SO26-0H02-0913 (a three-point composite sample), CAA06-SB01-1008, and CAA06-SB13-1108, respectively.

All of the detections of explosive constituents exceeding screening criteria in surface and subsurface soil were located in the vicinity of the TNT Catch Box Ruins or immediately southeast of the former TNT Graining House, and are attributable to historical activities at these subareas (**Figure 4-2 and Figure 4-3**).

#### 4.1.2 Inorganic Constituents

Eight inorganic constituents in surface soil (**Figure 4-2**) and nine inorganic constituents in subsurface soil (**Figure 4-3**) were detected at the AOC 6 TNT Subareas at concentrations exceeding their respective adjusted residential RSL and/or ESV.

- In surface soil, aluminum, arsenic, chromium, cobalt, iron, lead, thallium, and vanadium concentrations exceeded the adjusted residential RSL or ESV in at least one sample. These detected concentrations also exceeded their respective Base background 95 percent UTL at one or more sample locations, except for thallium, which does not have a 95 percent UTL.
  - Arsenic concentrations in surface soil were detected above the adjusted residential RSL (0.61 milligram per kilogram [mg/kg]) (but not the ESV) and Base background 95 percent UTL (6.36 mg/kg) in two of the 20 surface soil samples analyzed for inorganic constituents (CAA06-SS01-1008 and CAA06-SS03-1008).
  - Aluminum, chromium, and vanadium concentrations exceeding the 95 percent UTLs were only detected in one out of 20 surface soil samples (CAA06-SS03-1008). Lead concentrations exceeding the 95 percent UTL were only detected in two out of 20 surface soil samples (CAA06-SS01-1008 and three-point composite sample CAA06-SO26-000H-0913). Iron concentrations exceeding the 95 percent UTL were only detected in three out of 20 surface soil samples (CAA06-SS01-1008, CAA06-SS03-1008, and three-point composite sample CAA06-SO26-000H-0913).
  - Thallium concentrations in surface soil were detected above the adjusted residential RSL (0.078 mg/kg) in 11 of 20 surface soil samples.
- In subsurface soil, aluminum, arsenic, hexavalent chromium, chromium, cobalt, iron, lead, thallium, and vanadium concentrations exceeded the adjusted residential RSL or ESV in at least one sample. In addition, these detected concentrations also exceeded their respective Base background 95 percent UTL in at least one sample location, except for hexavalent chromium and thallium, neither of which have a 95 percent UTL.

- Arsenic concentrations in subsurface soil were detected above the adjusted residential RSL (0.61 mg/kg) and Base background 95 percent UTL (5.54 mg/kg) in six of the 20 subsurface soil samples analyzed for inorganic constituents. The maximum concentration of 20.9 J mg/kg was detected in sample CAA06-SB01-1008, where this concentration also exceeded the ESV.
- Iron, lead, and vanadium concentrations exceeding the 95 percent UTLs were only detected in one out of the 20 subsurface soil samples. Chromium concentrations exceeding the 95 percent UTLs were only detected in two out of 20 subsurface soil samples (CAA06-SB01-1008 and CAA06-SB03-1008). Aluminum concentrations exceeding the 95 percent UTLs were only detected in five out of 20 subsurface soil samples CAA06-SB36-0H02-0913, CAA06-SB02-1008, CAA06-SB03-1008, CAA06-SB13-1108, and CAA06-SB31-0H02-0913).
- Hexavalent chromium concentrations in subsurface soil were detected above the adjusted residential RSL (0.3 mg/kg) at 0.31 J mg/kg and 0.94 mg/kg in two out of two subsurface soil samples, CAA06-SB26P-0H02-0913 and CAA06-SB27-0H02-0913, respectively.
- Thallium concentrations in surface soil were detected above the adjusted residential RSL (0.078 mg/kg) in 12 of 20 subsurface soil samples.

The detections of inorganic constituents exceeding screening criteria in surface and subsurface soil were distributed throughout the AOC 6 TNT Subareas and are not concentrated within the TNT Catch Box Ruins or immediately southeast of the former TNT Graining House (**Figure 4-2 and Figure 4-3**).

## 4.2 Groundwater

A total of six groundwater samples (CAA06-GW01 through CAA06-GW06) were collected from the AOC 6 TNT Subareas (**Table 4-3**) during the RI to evaluate groundwater conditions and to assess the potential for human health or environmental risks associated with this medium (**Figure 4-4**). Four DPT groundwater samples were also collected during the 2012 SI, analyzed for SVOCs, total and dissolved inorganic constituents, cyanide, and explosives, and the analytical data were used to site the six RI monitoring well locations. However, since the SI groundwater samples were collected from temporary monitoring wells, the DPT data may not be representative of current groundwater concentrations; consequently, these data were not evaluated in the RI. During the RI, groundwater samples were collected from the newly installed permanent monitoring wells and analyzed for potentially site-related contaminants based on earlier results (total/dissolved inorganic constituents) and monitored natural attenuation parameters (pH, alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, TOC, ferrous iron, and DO).

A summary of the groundwater sampling results is presented as follows; a discussion of the results and significance of each natural attenuation parameter and more details regarding aquifer geochemical conditions within groundwater are presented in **Section 7**.

### 4.2.1 General Groundwater Geochemistry

Measurements of DO, ORP, pH, temperature, conductivity, and turbidity were collected at each monitoring well following purging and immediately prior to sampling (**Table 2-3**). The DO readings collected during purging activities, which provide an indication of the potential for aerobic or anaerobic biodegradation, ranged between 0.0 milligram per liter (mg/L) and 1.32 mg/L. Temperature readings ranged between 18.91 degrees Celsius (°C) and 21.86°C. The ORP values, which indicate the potential for redox conditions in groundwater, ranged between -179.1 millivolts (mV) and -53.0 mV, and pH values were generally close to neutral, ranging between 6.33 and 6.84. Conductivity values, which provide an indication of the concentration of total dissolved solids within groundwater, ranged between 0.231 milliSiemen per centimeter (mS/cm) and 0.448 mS/cm, which are indicative of freshwater conditions. Further details regarding groundwater geochemistry and its applicability to contaminant fate and transport are discussed in **Section 7.1.7**.

## 4.2.2 Inorganic Constituents

Five total inorganic constituents and four dissolved inorganic constituents were detected at concentrations exceeding either the adjusted Tapwater RSL or federal MCL (**Figure 4-4**). Since the surficial aquifer underlying the AOC 6 TNT Subareas is the Columbia aquifer, and CAX background concentrations for groundwater are not available for this aquifer, groundwater concentrations in the site-specific upgradient monitoring wells CAA06-MW01 and CAA06-MW06 were used for comparison purposes.

- Total and dissolved arsenic exceeded the MCL and adjusted Tapwater RSL in five groundwater samples; however, all of the concentrations in monitoring wells within the study area boundary were below those detected in reference monitoring well CAA06-MW06, which is upgradient of the AOC 6 TNT Subareas. The arsenic concentrations were also higher compared to monitoring well CAA06-MW03, which is also upgradient of the former TNT Graining House, Sump, and Catch Box Ruins since Penniman Lake was found to be recharging the surficial aquifer during the RI. Arsenic concentrations in groundwater at the AOC 6 TNT Subareas appear to be representative of naturally occurring conditions, as arsenic concentrations are typically elevated in the shallow coastal plain of southeast Virginia due to the aquifer composition and geochemical conditions. Arsenic is commonly adsorbed to, or co-precipitated with, iron and manganese oxides, adsorbed to clay mineral surfaces, and associated with sulfide minerals. Natural dissolving or desorbing of arsenic from these source materials releases arsenic to groundwater. In addition, the U.S. Geological Survey (USGS) has collected and analyzed arsenic in potable (drinkable) water from 18,850 wells in 595 counties across the United States during the past two decades, and naturally occurring arsenic concentrations in southeast Virginia are typically detected above the MCL (USGS, 2000).
- Total cyanide was detected at a concentration exceeding the adjusted Tapwater RSL in only one sample (CAA06-GW05-1013); however, this concentration likely represents elevated suspended solids within the sample since this inorganic constituent was not detected within the corresponding dissolved sample.
- Total and dissolved cobalt concentrations exceeded the adjusted Tapwater RSL (0.6 microgram per liter [ $\mu\text{g/L}$ ]) in the five of the six groundwater samples. However, the maximum total and dissolved concentrations of 8.7  $\mu\text{g/L}$  were detected in reference groundwater sample CAA06-GW01P-1013, upgradient of the AOC 6 TNT Subareas. These concentrations are likely attributable to naturally occurring background conditions.
- Total iron and manganese concentrations exceeded their respective adjusted Tapwater RSLs in each of the six groundwater samples. The maximum concentrations of total and dissolved iron detected in sample CAA06-GW02-1013 exceeded the respective concentrations detected in groundwater from reference wells CAA06-MW01 and CAA06-MW06, but were not significantly higher than the concentrations in reference well CAA06-MW06 and upgradient monitoring well CAA06-MW03. The concentrations of iron in groundwater are likely attributable to naturally occurring background conditions. With respect to total and dissolved manganese in groundwater samples, detected concentrations did not exceed those detected in groundwater in reference well CAA06-MW01. Similar to iron, manganese concentrations in groundwater are also likely attributable to naturally occurring, background conditions.

Iron and manganese concentrations are typically elevated in groundwater of the shallow coastal plain of southeast Virginia due to the aquifer composition and geochemical conditions. Iron oxides can be variable within soil as a result of chemical weathering. The ORP and DO values listed in Table 2-3 suggest a more reducing environment at the AOC 6 subareas. Under these conditions, iron hydroxides and manganese oxides present in the soil matrix can reductively dissolve into soluble forms as evidenced by elevated iron and manganese concentrations within groundwater.

TABLE 4-1

Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01
Sample ID				CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913	CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS01-1008
Sample Date				09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08
Chemical Name										
Semivolatile Organic Compounds (µg/kg)										
2,4-Dinitrotoluene	--	1,700	11,000	220 U	270 U	270 U	1,400	390 U	400 J	6,300 L
Benzaldehyde	--	780,000	58,400	NA	NA	NA	NA	NA	NA	320 J
Benzo(a)anthracene	--	150	HMW PAH	NA	NA	NA	NA	NA	NA	110 J
Chrysene	--	15,000	HMW PAH	NA	NA	NA	NA	NA	NA	150 J
Fluoranthene	--	230,000	LMW PAH	NA	NA	NA	NA	NA	NA	300 J
Pyrene	--	170,000	HMW PAH	NA	NA	NA	NA	NA	NA	580 J
HMW PAH Total	--	--	18,000	NA	NA	NA	NA	NA	NA	2,070 J
LMW PAH Total	--	--	29,000	NA	NA	NA	NA	NA	NA	1,940 J
Explosives (µg/kg)										
1,3,5-Trinitrobenzene	--	220,000	--	220 U	270 U	270 U	220 U	390 U	400 J	620 K
1,3-Dinitrobenzene	--	620	--	220 U	270 U	270 U	220 U	390 U	220 U	730 J
2,4,6-Trinitrotoluene	--	3,600	10,000	220 U	270 U	270 U	910,000	390 U	720,000	4,500,000
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	220 U	270 U	270 U	7,100	390 U	220 U	100 UJ
2-Nitrotoluene	--	3,200	--	220 U	270 U	270 U	220 U	390 U	220 U	40,000 R
3,5-Dinitroaniline	--	--	--	220 U	270 U	270 U	220 U	390 U	220 U	100 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	220 U	270 U	270 U	4,500	390 U	13,000	20,000 R
RDX	--	6,000	10,000	220 U	270 U	270 U	220 U	390 U	220 U	220
Tetryl	--	12,000	10,000	220 U	270 U	270 U	220 U	390 U	220 U	640
Total Metals (mg/kg)										
Aluminum	12,200	7,700	pH<5.5	3,600	7,600	8,500	6,900	2,700	5,200	10,600
Antimony	--	3.1	78	0.097 B	0.2 B	0.2 B	0.36	0.16 B	0.62	14 UL
Arsenic	6.36	0.67	18	1.7	5.2	5.2	3.1	1.6	2.2	8.1 J
Barium	52.9	1,500	330	22	18	20	26	9.4	17	31
Beryllium	0.587	16	40	0.37	0.44 J	0.34 J	0.2	0.092 J	0.24	0.34 J
Cadmium	--	7	32	0.033 J	0.033 J	0.031 J	0.061	0.021 J	0.042 J	0.06 J
Calcium	2,290	--	--	230	270	280	430	330	220	2,260
Chromium	18.2	0.3	64	5.5	11	12	8.5 K	3.6	6.4	16.8 L
Cobalt	9.93	2.3	13	3	2.4	2.6	2.5	0.57	1.7	3.6 J
Copper	4.25	310	70	1.5	2.5	2.7	13 K	1.2	2.5	9.8
Cyanide	--	2.1	15.8	0.066 J	0.047 J	0.044 J	0.19 B	0.13	0.47	0.6 U
Iron	19,900	5,500	pH<5 or pH>8	3,800	12,000	14,000	8,500	3,900	6,200	37,100 J
Lead	17.4	400	120	16	10	11	34	16	170	580 J
Magnesium	1,070	--	--	270	580	640	680	200	390	896 J
Manganese	324	180	220	51	36	36	62	12	31	175
Mercury	0.111	2.3	0.1	0.038 B	0.05	0.045 B	0.089	0.062	0.084	0.13 L
Nickel	9.52	150	38	3	4	4.3	3.8 K	1.6	3.8	10.1
Potassium	708	--	--	190	590	680	350	180	310	719
Selenium	0.51	39	0.52	0.14 B	0.2	0.19	0.2	0.24 B	0.32	2 J
Silver	--	39	560	0.026 J	0.021 J	0.022 J	0.026 J	0.022 J	0.055	2.3 U
Sodium	521	--	--	7.2 B	12 B	12 B	15 B	13 B	10 B	68 J
Thallium	--	0.078	1	0.063	0.094	0.1	0.083	0.058	0.09	5.7 U
Vanadium	27.9	39	130	7.6	20	23	18	12	14	26.6
Zinc	26.5	2,300	120	15 B	14	17	29	7.1	17	96.7

TABLE 4-1  
Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01
Sample ID				CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913	CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS01-1008
Sample Date				09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08
Wet Chemistry										
pH (ph)	--	--	--	5.4	5.1	NA	4.6	4.1	4.4	4.6
Total organic carbon (TOC) (mg/kg)	--	--	--	8,000	12,000	NA	17,000	65,000	20,000	120,000 J
Grain Size (pct)										
Coarse Sand (%)	--	--	--	0.3	3.9	NA	2.6	0.9	1.4	NA
Fine Sand (%)	--	--	--	51.4	43.4	NA	50	56.1	54.5	NA
Fines (%)	--	--	--	15.2	8.7	NA	16.3	22.3	19.4	NA
Gravel (%)	--	--	--	0.1	0.3	NA	0.9	1.1	0.4	NA
Medium Sand (%)	--	--	--	33	43.7	NA	30.2	19.6	24.3	NA
GRAINSIZE (PCT/P)										
GS07 Sieve 1" (25.0 mm)	--	--	--	100	100	NA	100	100	100	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	100	100	NA	100	100	100	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	100	100	NA	100	100	100	NA
Sieve No. 004 (4.75 mm)	--	--	--	99.9	99.7	NA	99.1	98.9	99.6	NA
Sieve No. 010 (2.00 mm)	--	--	--	99.6	95.8	NA	96.5	98	98.2	NA
Sieve No. 020 (850 um)	--	--	--	94.8	80.1	NA	87.7	94.3	92.7	NA
Sieve No. 040 (425 um)	--	--	--	66.6	52.1	NA	66.3	78.4	73.9	NA
Sieve No. 060 (250 um)	--	--	--	38.4	30.4	NA	42.8	55.6	50.7	NA
Sieve No. 080 (180 um)	--	--	--	29.7	22.1	NA	32.8	42.8	38.8	NA
Sieve No. 100 (150 um)	--	--	--	26.4	18.8	NA	28.9	37.5	34.2	NA
Sieve No. 200 (75 um)	--	--	--	15.2	8.7	NA	16.3	22.3	19.4	NA

Notes:  
**Bold text indicates exceedance of CAX 95% UTL BKG SS**  
Shading indicates exceedance of CLEAN RSLs Residential Soil Adjusted (May 2014)  
Underline indicates exceedance of ESV  
RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents  
<sup>1</sup>3-point composite surface soil sample  
NA - Not analyzed  
B - Analyte not detected above the level reported in blanks  
J - Analyte present, value may or may not be accurate or precise  
K - Analyte present, value may be biased high, actual value may be lower  
L - Analyte present, value may be biased low, actual value may be higher  
R - Rejected Result  
U - The material was analyzed for, but not detected  
UJ - Analyte not detected, quantitation limit may be inaccurate  
UL - Analyte not detected, quantitation limit is probably higher  
mg/kg - Milligrams per kilogram  
pct - Percent  
PCT/P - Percent Pass  
ph - pH units  
µg/kg - Micrograms per kilogram

TABLE 4-1

Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13
Sample ID				CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108	CAA06-SS13-1108
Sample Date				10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08
Chemical Name									
Semivolatile Organic Compounds (µg/kg)									
2,4-Dinitrotoluene	--	1,700	11,000	140 J	380 U	380 U	460 U	99 U	290
Benzaldehyde	--	780,000	58,400	380 U	380 U	380 U	460 U	430 U	370 U
Benzo(a)anthracene	--	150	HMW PAH	380 U	380 U	380 U	460 U	430 U	370 U
Chrysene	--	15,000	HMW PAH	380 U	380 U	380 U	460 U	430 U	370 U
Fluoranthene	--	230,000	LMW PAH	380 U	380 U	380 U	460 U	430 U	370 U
Pyrene	--	170,000	HMW PAH	380 U	380 U	380 U	460 U	430 U	370 U
HMW PAH Total	--	--	18,000	1,710 U	1,710 U	1,710 U	2,070 U	1,935 U	1,665 U
LMW PAH Total	--	--	29,000	1,710 U	1,710 U	1,710 U	2,070 U	1,935 U	1,665 U
Explosives (µg/kg)									
1,3,5-Trinitrobenzene	--	220,000	--	250	100 U	100 U	100 U	99 U	1,100
1,3-Dinitrobenzene	--	620	--	84 J	100 UJ	100 U	100 U	99 U	290
2,4,6-Trinitrotoluene	--	3,600	10,000	320,000	6,600	170	100 U	99 U	51,000
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	16,000 J	1,400 J	100 U	100 U	99 U	15,000
2-Nitrotoluene	--	3,200	--	48,000 J	200 UJ	200 U	200 U	200 U	200 U
3,5-Dinitroaniline	--	--	--	100 U	100 U	100 U	100 U	99 UJ	890
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	17,000	1,400	100 U	100 U	99 U	14,000
RDX	--	6,000	10,000	200 U	200 U	200 U	200 U	200 U	200 U
Tetryl	--	12,000	10,000	200 U	200 U	200 U	200 U	200 U	200 U
Total Metals (mg/kg)									
Aluminum	12,200	7,700	pH<5.5	10,400	25,000	9,630	5,230	6,780	11,400
Antimony	--	3.1	78	4.1 UL	0.21 L	0.1 L	4.5 UL	7.4 UL	4 UL
Arsenic	6.36	0.67	18	3.5 J	11.8 J	3.6 J	2.7 L	3.3 L	5 L
Barium	52.9	1,500	330	22.9	45.7	18.8 J	21.2 K	18.3 K	25.2 K
Beryllium	0.587	16	40	0.36	0.55	0.29 J	0.4	0.26 J	0.39
Cadmium	--	7	32	0.09 J	0.12 J	0.04 J	0.38 U	0.05 B	0.02 B
Calcium	2,290	--	--	748	1,980	1,210	304 J	869	415
Chromium	18.2	0.3	64	12.5 L	34.7 L	16.2 L	6.1	8.6	13.9
Cobalt	9.93	2.3	13	2.2 J	3.4 J	1.9 J	2.6 J	1.3 J	2.4 J
Copper	4.25	310	70	6.7	5.5	3.6	2.2 B	4.8 B	4.2 B
Cyanide	--	2.1	15.8	0.55 U	0.55 U	0.5 U	0.7 U	0.6 U	1.3
Iron	19,900	5,500	pH<5 or pH>8	9,000 J	21,700 J	9,010 J	4,780	6,270	10,300
Lead	17.4	400	120	72.9 J	42.8 J	9.9 J	10.8	18.5	101
Magnesium	1,070	--	--	672	1,270	694	406	468 J	747
Manganese	324	180	220	43.3	32.8	25.4	50.5 L	30.9 L	41.1 L
Mercury	0.111	2.3	0.1	0.05 L	0.12 UL	0.11 UL	0.15 UL	0.06 L	0.08 L
Nickel	9.52	150	38	6.6	10	4.8	3.7	4.1 J	7
Potassium	708	--	--	620	1,520	875	254 J	438 J	589 J
Selenium	0.51	39	0.52	0.38 J	0.91 J	3.8 U	2.6 U	4.3 U	0.38 J
Silver	--	39	560	0.69 U	0.95 U	1.1 U	0.75 U	1.2 U	0.67 U
Sodium	521	--	--	29.5 J	58.7 J	28.6 J	19 B	36.3 B	27.2 B
Thallium	--	0.078	1	1.7 U	0.18 J	2.7 U	1.9 U	3.1 U	0.09 B
Vanadium	27.9	39	130	19.6	50	22.1	10.3	18.1	22.5
Zinc	26.5	2,300	120	54.9	176	17	12.2 K	18.6 K	25.9 K

TABLE 4-1

Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13
Sample ID				CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108	CAA06-SS13-1108
Sample Date				10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08
Wet Chemistry									
pH (ph)	--	--	--	6.8	7.1	7.1	5.4	5	5
Total organic carbon (TOC) (mg/kg)	--	--	--	7,300 J	6,200 J	27,000 J	22,000	49,000	30,000
Grain Size (pct)									
Coarse Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)									
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SS**

Shading indicates exceedance of CLEAN RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite surface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

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R - Rejected Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-1

Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29
Sample ID				CAA06-SS26-0913	CAA06-SS26P-0913 <sup>1</sup>	CAA06-SO26-000H-0913	CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913
Sample Date				09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13
Chemical Name									
Semivolatile Organic Compounds (µg/kg)									
2,4-Dinitrotoluene	--	1,700	11,000	NA	NA	270 U	NA	230 U	220 U
Benzaldehyde	--	780,000	58,400	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	--	150	HMW PAH	NA	NA	NA	NA	NA	NA
Chrysene	--	15,000	HMW PAH	NA	NA	NA	NA	NA	NA
Fluoranthene	--	230,000	LMW PAH	NA	NA	NA	NA	NA	NA
Pyrene	--	170,000	HMW PAH	NA	NA	NA	NA	NA	NA
HMW PAH Total	--	--	18,000	NA	NA	NA	NA	NA	NA
LMW PAH Total	--	--	29,000	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)									
1,3,5-Trinitrobenzene	--	220,000	--	NA	NA	20,000	NA	230 U	220 U
1,3-Dinitrobenzene	--	620	--	NA	NA	2,500	NA	230 U	220 U
2,4,6-Trinitrotoluene	--	3,600	10,000	NA	NA	14,000,000	NA	230 U	220 U
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	NA	NA	270 U	NA	230 U	220 U
2-Nitrotoluene	--	3,200	--	NA	NA	270 U	NA	230 U	220 U
3,5-Dinitroaniline	--	--	--	NA	NA	1,600	NA	230 U	220 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	NA	NA	270 U	NA	230 U	220 U
RDX	--	6,000	10,000	NA	NA	380 J	NA	230 U	220 U
Tetryl	--	12,000	10,000	NA	NA	270 U	NA	230 U	220 U
Total Metals (mg/kg)									
Aluminum	12,200	7,700	pH<5.5	NA	NA	7,600	NA	12,000	7,600
Antimony	--	3.1	78	NA	NA	0.31	NA	0.2	0.23
Arsenic	6.36	0.67	18	NA	NA	6.1	NA	6	5.4
Barium	52.9	1,500	330	NA	NA	32	NA	27	13
Beryllium	0.587	16	40	NA	NA	0.35	NA	0.58	0.4
Cadmium	--	7	32	NA	NA	0.29	NA	0.022 J	0.031 J
Calcium	2,290	--	--	NA	NA	4,000	NA	170	140
Chromium	18.2	0.3	64	20	17	10	13	16	12
Cobalt	9.93	2.3	13	NA	NA	2.2	NA	2.5	1.9
Copper	4.25	310	70	NA	NA	9.5	NA	4.1	2.8
Cyanide	--	2.1	15.8	NA	NA	0.57	NA	0.042 B	0.087 J
Iron	19,900	5,500	pH<5 or pH>8	NA	NA	38,000	NA	14,000	14,000
Lead	17.4	400	120	NA	NA	1,100	NA	12	19
Magnesium	1,070	--	--	NA	NA	740	NA	690	560
Manganese	324	180	220	NA	NA	92	NA	39	31
Mercury	0.111	2.3	0.1	NA	NA	0.13	NA	0.075	0.046 J
Nickel	9.52	150	38	NA	NA	6.3	NA	4.9	3.8
Potassium	708	--	--	NA	NA	650	NA	490	670
Selenium	0.51	39	0.52	NA	NA	0.33	NA	0.28	0.21
Silver	--	39	560	NA	NA	0.052	NA	0.017 J	0.025 J
Sodium	521	--	--	NA	NA	38 J	NA	15 J	14 J
Thallium	--	0.078	1	NA	NA	0.095	NA	0.14	0.086
Vanadium	27.9	39	130	NA	NA	25	NA	27	24
Zinc	26.5	2,300	120	NA	NA	120	NA	19 B	16

TABLE 4-1

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AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29
Sample ID				CAA06-SS26-0913	CAA06-SS26P-0913 <sup>1</sup>	CAA06-SO26-000H-0913	CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913
Sample Date				09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13
Wet Chemistry									
pH (ph)	--	--	--	NA	NA	5.7	NA	4.9	4.8
Total organic carbon (TOC) (mg/kg)	--	--	--	NA	NA	120,000	NA	15,000	22,000
Grain Size (pct)									
Coarse Sand (%)	--	--	--	NA	NA	8.2	NA	9.7	2
Fine Sand (%)	--	--	--	NA	NA	42.3	NA	38.7	46.7
Fines (%)	--	--	--	NA	NA	8.2	NA	11.3	8.4
Gravel (%)	--	--	--	NA	NA	3.2	NA	0.7	0.5
Medium Sand (%)	--	--	--	NA	NA	38.1	NA	39.6	42.4
GRAINSIZE (PCT/P)									
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	100	NA	100	100
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	100	NA	100	100
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	100	NA	100	100
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	96.8	NA	99.3	99.5
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	88.6	NA	89.6	97.5
Sieve No. 020 (850 um)	--	--	--	NA	NA	73	NA	71.5	85.9
Sieve No. 040 (425 um)	--	--	--	NA	NA	50.5	NA	50	55.1
Sieve No. 060 (250 um)	--	--	--	NA	NA	30	NA	31.9	30.3
Sieve No. 080 (180 um)	--	--	--	NA	NA	21.3	NA	23.5	22.3
Sieve No. 100 (150 um)	--	--	--	NA	NA	17.9	NA	20.2	19.1
Sieve No. 200 (75 um)	--	--	--	NA	NA	8.2	NA	11.3	8.4

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SS**

Shading indicates exceedance of CLEAN RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite surface soil sample

NA - Not analyzed

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pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-1

Surface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID				CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS39-0913
Sample Date				09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name								
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	--	1,700	11,000	220 U	220 U	220 U	220 U	220 U
Benzaldehyde	--	780,000	58,400	NA	NA	NA	NA	NA
Benzo(a)anthracene	--	150	HMW PAH	NA	NA	NA	NA	NA
Chrysene	--	15,000	HMW PAH	NA	NA	NA	NA	NA
Fluoranthene	--	230,000	LMW PAH	NA	NA	NA	NA	NA
Pyrene	--	170,000	HMW PAH	NA	NA	NA	NA	NA
HMW PAH Total	--	--	18,000	NA	NA	NA	NA	NA
LMW PAH Total	--	--	29,000	NA	NA	NA	NA	NA
Explosives (µg/kg)								
1,3,5-Trinitrobenzene	--	220,000	--	220 U	220 U	220 U	220 U	220 U
1,3-Dinitrobenzene	--	620	--	220 U	220 U	220 U	220 U	220 U
2,4,6-Trinitrotoluene	--	3,600	10,000	770	1,900	220 U	220 U	220 U
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	870	1,200	220 U	220 U	220 U
2-Nitrotoluene	--	3,200	--	220 U	220 U	220 U	220 U	220 U
3,5-Dinitroaniline	--	--	--	220 U	220 U	220 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	710	980	220 U	220 U	220 U
RDX	--	6,000	10,000	220 U	220 U	220 U	220 U	220 U
Tetryl	--	12,000	10,000	220 U	220 U	220 U	220 U	220 U
Total Metals (mg/kg)								
Aluminum	12,200	7,700	pH<5.5	<u>6,800</u>	<u>4,400</u>	<u>4,200</u>	<u>4,900</u>	<u>3,700</u>
Antimony	--	3.1	78	0.16	0.1	0.089 J	0.12	0.15 B
Arsenic	6.36	0.67	18	2.7	1.2	1.1	1.6	1.4
Barium	52.9	1,500	330	15	15	16	20	14
Beryllium	0.587	16	40	0.19	0.19	0.28	0.37	0.24
Cadmium	--	7	32	0.017 J	0.018 J	0.032 J	0.046 J	0.028 J
Calcium	2,290	--	--	61	170	210	510	180
Chromium	18.2	0.3	64	8.5	4.4	4.3	5.3	3.9
Cobalt	9.93	2.3	13	1.6	1.1	1.2	1.8	1
Copper	4.25	310	70	4.8	1.4	1.2	1.5	1.3
Cyanide	--	2.1	15.8	0.089 J	0.081 J	0.055 B	0.11 B	0.08 J
Iron	19,900	5,500	pH<5 or pH>8	<u>8,800</u>	<u>5,300</u>	4,000	5,300	<u>4,000</u>
Lead	17.4	400	120	31	110	59	21	18
Magnesium	1,070	--	--	430	380	340	440	280
Manganese	324	180	220	29	16	22	35	17
Mercury	0.111	2.3	0.1	0.066	0.063	0.057	0.048 J	0.038 B
Nickel	9.52	150	38	3.4	2.6	2.8	3.6	2.4
Potassium	708	--	--	310	230	210	240	210
Selenium	0.51	39	0.52	0.11	0.049 J	0.1	0.15	0.14 B
Silver	--	39	560	0.021 J	0.029 J	0.019 J	0.026 J	0.028 J
Sodium	521	--	--	14 J	9.7 J	8.7 J	11 J	9.2 B
Thallium	--	0.078	1	0.1	0.089	0.081	0.094	0.074
Vanadium	27.9	39	130	17	12	8.4	12	9.7
Zinc	26.5	2,300	120	17	12	18 B	17	8.3

TABLE 4-1

Surface Soil Data Exceedance Results

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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CAX 95% UTL BKG SS	RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID				CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS39-0913
Sample Date				09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Wet Chemistry								
pH (ph)	--	--	--	4.4	4.6	5	5.2	4.8
Total organic carbon (TOC) (mg/kg)	--	--	--	10,000	12,000	11,000	25,000	19,000
Grain Size (pct)								
Coarse Sand (%)	--	--	--	1.8	0.3	0.3	1.2	1
Fine Sand (%)	--	--	--	49.6	53	56.1	53.9	56.1
Fines (%)	--	--	--	19.9	26.7	25.7	19.6	21.8
Gravel (%)	--	--	--	1.7	0.1	0.1	2.6	0.4
Medium Sand (%)	--	--	--	27	19.9	17.8	22.7	20.7
GRAINSIZE (PCT/P)								
GS07 Sieve 1" (25.0 mm)	--	--	--	100	100	100	100	100
GS08 Sieve 0.75" (19.0 mm)	--	--	--	100	100	100	100	100
GS10 Sieve 0.375" (9.5 mm)	--	--	--	100	100	100	100	100
Sieve No. 004 (4.75 mm)	--	--	--	98.3	99.9	99.9	97.4	99.6
Sieve No. 010 (2.00 mm)	--	--	--	96.5	99.6	99.6	96.2	98.6
Sieve No. 020 (850 um)	--	--	--	89.4	97	97	91.4	95.1
Sieve No. 040 (425 um)	--	--	--	69.5	79.7	81.8	73.5	77.9
Sieve No. 060 (250 um)	--	--	--	47.5	56.9	59.3	51.4	54.8
Sieve No. 080 (180 um)	--	--	--	37	45.5	46	39.3	42.1
Sieve No. 100 (150 um)	--	--	--	32.8	40.9	40.9	34.6	37.2
Sieve No. 200 (75 um)	--	--	--	19.9	26.7	25.7	19.6	21.8

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SS**

Shading indicates exceedance of CLEAN RSLs Residential Soil Adjusted (May 2014)

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RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

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UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04
Sample ID				CAA06-SB34-0H02-0913	CAA06-SB35-0H02-0913	CAA06-SB35P-0H02-0913	CAA06-SB36-0H02-0913	CAA06-SB37-0H02-0913
Sample Date				09/17/13	09/17/13	09/17/13	09/17/13	09/17/13
Chemical Name								
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	--	1,700	11,000	210 U	230 U	260 U	700	240 U
2,6-Dinitrotoluene	--	360	8,500	210 U	230 U	260 U	250 U	240 U
Explosives (µg/kg)								
1,3,5-Trinitrobenzene	--	220,000	--	210 U	230 U	260 U	250 U	240 U
1,3-Dinitrobenzene	--	620	--	210 U	230 U	260 U	250 U	240 U
2,4,6-Trinitrotoluene	--	3,600	10,000	210 U	230 U	260 U	490,000	240 U
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	210 U	230 U	260 U	3,200	240 U
3,5-Dinitroaniline	--	--	--	210 U	230 U	260 U	250 U	240 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	210 U	230 U	260 U	2,300	240 U
4-Nitrotoluene	--	25,000	--	210 U	230 U	260 U	3,200	240 U
RDX	--	6,000	10,000	210 U	230 U	260 U	250 U	240 U
Total Metals (mg/kg)								
Aluminum	13,000	7,700	pH<5.5	3,000	11,000	11,000	15,000	9,500
Antimony	--	3.1	78	0.07 B	0.15 B	0.14 B	0.21 B	0.18 B
Arsenic	5.54	0.67	18	1.4	3.8	3.8	5.6 L	5.4
Barium	84.5	1,500	330	19	32	30	29	17
Beryllium	--	16	40	0.36	0.48	0.55	0.63	0.25
Cadmium	--	7	32	0.022 J	0.022 J	0.027 J	0.019 J	0.015 J
Calcium	2,380	--	--	100	1,000	940	69	170
Chromium (hexavalent)	--	0.3	0.4	NA	NA	NA	NA	NA
Chromium	33.7	0.3	64	4.1	13	11	18	13
Cobalt	5.18	2.3	13	2.7	3.6	3.3	3.2	2
Copper	3.17	310	70	0.79	2.6	2.7	4.1	2.4
Cyanide	--	2.1	15.8	0.052 U	0.054 U	0.055 U	0.084 L	0.035 J
Iron	32,000	5,500	pH<5 or pH>8	3,900	12,000	12,000	17,000	12,000
Lead	8.79	400	120	4	7.8	7.4	13 L	9.6
Magnesium	1,120	--	--	270	870	860	830	510
Manganese	176	180	220	32	62	55	69	27
Mercury	--	2.3	0.1	0.02 B	0.044 B	0.049 J	0.055	0.041 B
Nickel	17.6	150	38	2.6	6.1	5.7	6.7	4.2
Potassium	901	--	--	180	470	440	550	410
Selenium	--	39	0.52	0.065 B	0.35	0.33	0.36 L	0.35
Silver	--	39	560	0.014 J	0.02 J	0.023 J	0.026 J	0.02 J
Sodium	811	--	--	23 U	23 B	22 B	21 B	16 B
Thallium	--	0.078	1	0.054	0.14	0.13	0.17	0.12
Vanadium	48.3	39	130	6.4	23	21	30	22
Zinc	28	2,300	120	8.5	20 B	18 B	27	16

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04
Sample ID				CAA06-SB34-OH02-0913	CAA06-SB35-OH02-0913	CAA06-SB35P-OH02-0913	CAA06-SB36-OH02-0913	CAA06-SB37-OH02-0913
Sample Date				09/17/13	09/17/13	09/17/13	09/17/13	09/17/13
Wet Chemistry								
pH (ph)	--	--	--	5.7	6.4	NA	4.3	4.5
Total organic carbon (TOC) (mg/kg)	--	--	--	1,200	4,500	NA	7,700	12,000
Grain Size (pct)								
Coarse Sand (%)	--	--	--	NA	NA	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)								
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SB**

Shading indicates exceedance of RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite subsurface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08
Sample ID				CAA06-SB38-0H02-0913	CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108
Sample Date				09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08
Chemical Name										
Semivolatile Organic Compounds (µg/kg)										
2,4-Dinitrotoluene	--	1,700	11,000	260 U	1,700	450 U	380 U	360 U	390 U	370 U
2,6-Dinitrotoluene	--	360	8,500	260 U	99 U	450 U	380 U	360 U	390 U	370 U
Explosives (µg/kg)										
1,3,5-Trinitrobenzene	--	220,000	--	260 U	99 U	100 U	100 U	100 U	100 U	100 U
1,3-Dinitrobenzene	--	620	--	260 U	1,600 J	100 UJ	28 J	100 U	100 U	100 U
2,4,6-Trinitrotoluene	--	3,600	10,000	80,000	2,700,000	6,700	1,400	100 U	100 U	100 U
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	6,200	99 UJ	610 J	650 J	100 U	100 U	100 U
3,5-Dinitroaniline	--	--	--	260 U	99 U	100 U	100 U	100 U	100 U	100 UJ
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	7,900	99 U	100 U	340	100 U	100 U	100 U
4-Nitrotoluene	--	25,000	--	260 U	200 U	200 U	200 U	200 U	200 U	200 U
RDX	--	6,000	10,000	260 U	200 U	200 U	200 U	200 U	200 U	200 U
Total Metals (mg/kg)										
Aluminum	13,000	7,700	pH<5.5	7,200	10,400	16,200	23,600	10,400	4,200	9,950
Antimony	--	3.1	78	0.72	10 UL	6.8 UL	11 UL	6 UL	4.6 UL	5.8 UL
Arsenic	5.54	0.67	18	2.7	20.9 J	9.6 J	14.4 J	6.8 J	2 L	4 L
Barium	84.5	1,500	330	21	15.3 J	24.5	35.9	13.5 J	16.4 K	28.8 K
Beryllium	--	16	40	0.26	0.73	0.4 J	0.67	0.48 J	0.37 J	0.34 J
Cadmium	--	7	32	0.025 J	0.02 J	0.57 U	0.9 U	0.11 J	0.38 U	0.48 U
Calcium	2,380	--	--	330	578	910	1,340	578	104 J	1,120
Chromium (hexavalent)	--	0.3	0.4	NA	NA	NA	NA	NA	NA	NA
Chromium	33.7	0.3	64	8.4	34.4 L	23.6 L	36.3 L	19.7 L	5.2	12.5
Cobalt	5.18	2.3	13	2.2	3.3 J	3.5 J	5 J	2.5 J	2.4 J	1.8 J
Copper	3.17	310	70	1.9	4.3	4.6	8.1	3.9	1.5 B	2.7 B
Cyanide	--	2.1	15.8	0.21	0.55 U	0.65 U	0.6 U	0.55 U	0.5 U	0.55 U
Iron	32,000	5,500	pH<5 or pH>8	8,500	34,700 J	15,400 J	25,700 J	17,800 J	3,460	8,260
Lead	8.79	400	120	33	25 J	10.8 J	16.6 J	6.9 J	4.1	8.7
Magnesium	1,120	--	--	490	678 J	933	1,410	776	332 J	591
Manganese	176	180	220	34	108	31	37.4	26.5	31.8 L	36.9 L
Mercury	--	2.3	0.1	0.07	0.11 UL	0.14 UL	0.11 UL	0.1 UL	0.12 UL	0.086 UL
Nickel	17.6	150	38	4.2	7.2	8.3	17.2	5.6	3.3	5.2
Potassium	901	--	--	320	821	984	1,630	1,010	203 J	507 J
Selenium	--	39	0.52	0.27 B	1.4 J	0.64 J	1.6 J	0.62 J	2.7 U	0.4 J
Silver	--	39	560	0.011 J	1.7 U	1.1 U	1.8 U	1 U	0.77 U	0.96 U
Sodium	811	--	--	13 B	29.5 J	40.9 J	60.6 J	33.8 J	15.2 B	33.2 B
Thallium	--	0.078	1	0.1	4.2 U	2.8 U	4.5 U	0.07 J	1.9 U	0.12 B
Vanadium	48.3	39	130	16	32.6	33.4	54.2	28.3	6.9	19.1
Zinc	28	2,300	120	16	24	24.7	34.6	19.7	7.6 K	16.2 K

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08
Sample ID				CAA06-SB38-OH02-0913	CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108
Sample Date				09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08
Wet Chemistry										
pH (ph)	--	--	--	5.2	6	5.7	6.1	6.1	5.8	6.8
Total organic carbon (TOC) (mg/kg)	--	--	--	6,800	2,600 J	3,200 J	2,200 J	2,500 J	4,700	12,000
Grain Size (pct)										
Coarse Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)										
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA	NA	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SB**

Shading indicates exceedance of RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite subsurface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO13	CAA06-SO26			CAA06-SO27
Sample ID				CAA06-SB13-1108	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913	CAA06-SO26-0H02-0913 <sup>1</sup>	CAA06-SB27-0H02-0913
Sample Date				11/06/08	09/19/13	09/19/13	09/19/13	09/18/13
Chemical Name								
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	--	1,700	11,000	780	NA	NA	12,000	NA
2,6-Dinitrotoluene	--	360	8,500	370 U	NA	NA	280 U	NA
Explosives (µg/kg)								
1,3,5-Trinitrobenzene	--	220,000	--	100 U	NA	NA	12,000	NA
1,3-Dinitrobenzene	--	620	--	290	NA	NA	1,500	NA
2,4,6-Trinitrotoluene	--	3,600	10,000	660,000	NA	NA	9,300,000	NA
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	15,000	NA	NA	14,000	NA
3,5-Dinitroaniline	--	--	--	550	NA	NA	280 U	NA
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	30,000	NA	NA	12,000	NA
4-Nitrotoluene	--	25,000	--	200 U	NA	NA	280 U	NA
RDX	--	6,000	10,000	200 U	NA	NA	280 U	NA
Total Metals (mg/kg)								
Aluminum	13,000	7,700	pH<5.5	13,400	NA	NA	6,700	NA
Antimony	--	3.1	78	4.2 UL	NA	NA	0.29	NA
Arsenic	5.54	0.67	18	5.4 L	NA	NA	10	NA
Barium	84.5	1,500	330	25.4 K	NA	NA	21	NA
Beryllium	--	16	40	0.42	NA	NA	0.44	NA
Cadmium	--	7	32	0.35 U	NA	NA	0.14	NA
Calcium	2,380	--	--	482	NA	NA	1,800	NA
Chromium (hexavalent)	--	0.3	0.4	NA	0.27 J	0.31 J	NA	0.94
Chromium	33.7	0.3	64	16.3	21 J	15 J	12	18 K
Cobalt	5.18	2.3	13	2.6 J	NA	NA	2.9	NA
Copper	3.17	310	70	4.8 B	NA	NA	6	NA
Cyanide	--	2.1	15.8	0.54 J	NA	NA	0.42	NA
Iron	32,000	5,500	pH<5 or pH>8	11,900	NA	NA	31,000	NA
Lead	8.79	400	120	35.4	NA	NA	470	NA
Magnesium	1,120	--	--	855	NA	NA	610	NA
Manganese	176	180	220	39.4 L	NA	NA	130	NA
Mercury	--	2.3	0.1	0.05 L	NA	NA	0.058	NA
Nickel	17.6	150	38	7	NA	NA	4.5	NA
Potassium	901	--	--	687 J	NA	NA	730	NA
Selenium	--	39	0.52	0.41 J	NA	NA	0.18	NA
Silver	--	39	560	0.69 U	NA	NA	0.025 J	NA
Sodium	811	--	--	25.8 B	NA	NA	25 J	NA
Thallium	--	0.078	1	0.11 B	NA	NA	0.092	NA
Vanadium	48.3	39	130	23.9	NA	NA	21	NA
Zinc	28	2,300	120	20.8 K	NA	NA	66 B	NA

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO13	CAA06-SO26			CAA06-SO27
Sample ID				CAA06-SB13-1108	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913	CAA06-SO26-0H02-0913 <sup>1</sup>	CAA06-SB27-0H02-0913
Sample Date				11/06/08	09/19/13	09/19/13	09/19/13	09/18/13
Wet Chemistry								
pH (ph)	--	--	--	5.3	NA	NA	5.7	NA
Total organic carbon (TOC) (mg/kg)	--	--	--	5,600	NA	NA	22,000	NA
Grain Size (pct)								
Coarse Sand (%)	--	--	--	NA	NA	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)								
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SB**

Shading indicates exceedance of RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite subsurface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31
Sample ID				CAA06-SB28-0H02-0913	CAA06-SB29-0H02-0913	CAA06-SB30-0H02-0913	CAA06-SB31-0H02-0913
Sample Date				09/18/13	09/18/13	09/18/13	09/18/13
Chemical Name							
Semivolatile Organic Compounds (µg/kg)							
2,4-Dinitrotoluene	--	1,700	11,000	230 U	220 U	220 U	220 U
2,6-Dinitrotoluene	--	360	8,500	230 U	220 U	220 U	220 U
Explosives (µg/kg)							
1,3,5-Trinitrobenzene	--	220,000	--	230 U	220 U	220 U	220 U
1,3-Dinitrobenzene	--	620	--	230 U	220 U	220 U	220 U
2,4,6-Trinitrotoluene	--	3,600	10,000	230 U	220 U	220 U	1,500
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	230 U	220 U	220 U	4,400
3,5-Dinitroaniline	--	--	--	230 U	220 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	230 U	220 U	220 U	2,600
4-Nitrotoluene	--	25,000	--	230 U	220 U	220 U	220 U
RDX	--	6,000	10,000	230 U	220 U	220 U	220 U
Total Metals (mg/kg)							
Aluminum	13,000	7,700	pH<5.5	13,000	9,800	11,000	14,000
Antimony	--	3.1	78	0.19	0.22	0.14	0.15
Arsenic	5.54	0.67	18	4.2	5.2	3.6	4.1
Barium	84.5	1,500	330	28	17	24	32
Beryllium	--	16	40	0.44	0.33	0.53	0.53
Cadmium	--	7	32	0.016 J	0.029 J	0.033 J	0.034 J
Calcium	2,380	--	--	270	110	77	400
Chromium (hexavalent)	--	0.3	0.4	NA	NA	NA	NA
Chromium	33.7	0.3	64	16	14	13	14
Cobalt	5.18	2.3	13	2.9	2.5	2.5	3.7
Copper	3.17	310	70	2.6	3.8	2.5	3
Cyanide	--	2.1	15.8	0.055 U	0.052 B	0.038 B	0.077 J
Iron	32,000	5,500	pH<5 or pH>8	14,000	14,000	13,000	16,000
Lead	8.79	400	120	10	34	11	17
Magnesium	1,120	--	--	740	660	690	930
Manganese	176	180	220	30	39	27	69
Mercury	--	2.3	0.1	0.085	0.039 J	0.049 J	0.058
Nickel	17.6	150	38	5.2	4.7	5.1	7.8
Potassium	901	--	--	520	600	400	500
Selenium	--	39	0.52	0.32	0.21	0.26	0.3
Silver	--	39	560	0.015 J	0.029 J	0.018 J	0.021 J
Sodium	811	--	--	18 J	14 J	13 J	19 J
Thallium	--	0.078	1	0.15	0.12	0.14	0.16
Vanadium	48.3	39	130	27	23	23	28
Zinc	28	2,300	120	18	21	24	30

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31
Sample ID				CAA06-SB28-OH02-0913	CAA06-SB29-OH02-0913	CAA06-SB30-OH02-0913	CAA06-SB31-OH02-0913
Sample Date				09/18/13	09/18/13	09/18/13	09/18/13
Wet Chemistry							
pH (ph)	--	--	--	5.1	4.8	4.5	5.1
Total organic carbon (TOC) (mg/kg)	--	--	--	4,100	17,000	6,000	5,600
Grain Size (pct)							
Coarse Sand (%)	--	--	--	NA	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA	NA
GRAINSIZE (PCT/P)							
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SB**

Shading indicates exceedance of RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite subsurface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID				CAA06-SB32-OH02-0913	CAA06-SB33-OH02-0913	CAA06-SB39-OH02-0913
Sample Date				09/18/13	09/18/13	09/17/13
Chemical Name						
Semivolatile Organic Compounds (µg/kg)						
2,4-Dinitrotoluene	--	1,700	11,000	220 U	220 U	220 U
2,6-Dinitrotoluene	--	360	8,500	220 U	220 U	220 U
Explosives (µg/kg)						
1,3,5-Trinitrobenzene	--	220,000	--	220 U	220 U	220 U
1,3-Dinitrobenzene	--	620	--	220 U	220 U	220 U
2,4,6-Trinitrotoluene	--	3,600	10,000	220 U	220 U	220 U
2-Amino-4,6-dinitrotoluene	--	15,000	80,000	220 U	220 U	220 U
3,5-Dinitroaniline	--	--	--	220 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	--	15,000	80,000	220 U	220 U	220 U
4-Nitrotoluene	--	25,000	--	220 U	220 U	220 U
RDX	--	6,000	10,000	220 U	220 U	220 U
Total Metals (mg/kg)						
Aluminum	13,000	7,700	pH<5.5	8,600	5,000	9,100
Antimony	--	3.1	78	0.11	0.088 J	0.13 B
Arsenic	5.54	0.67	18	2.3	1.5	2.4
Barium	84.5	1,500	330	20	23	20
Beryllium	--	16	40	0.28	0.36	0.37
Cadmium	--	7	32	0.025 J	0.023 J	0.013 J
Calcium	2,380	--	--	240	350	110
Chromium (hexavalent)	--	0.3	0.4	NA	NA	NA
Chromium	33.7	0.3	64	9.3	6.1	9.1
Cobalt	5.18	2.3	13	2	1.9	2
Copper	3.17	310	70	1.5	0.92	1.5
Cyanide	--	2.1	15.8	0.029 B	0.03 B	0.054 U
Iron	32,000	5,500	pH<5 or pH>8	9,100	4,900	8,600
Lead	8.79	400	120	30	11	6.8
Magnesium	1,120	--	--	570	440	590
Manganese	176	180	220	30	31	21
Mercury	--	2.3	0.1	0.052	0.034 J	0.041 B
Nickel	17.6	150	38	4.1	3.7	3.9
Potassium	901	--	--	370	240	370
Selenium	--	39	0.52	0.17	0.2	0.26
Silver	--	39	560	0.015 J	0.015 J	0.018 J
Sodium	811	--	--	13 J	9.6 J	12 B
Thallium	--	0.078	1	0.11	0.11	0.12
Vanadium	48.3	39	130	19	9.9	18
Zinc	28	2,300	120	27	14	14

TABLE 4-2

Subsurface Soil Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	CLEAN CAX 95% UTL BKG SB	CLEAN RSLs Residential Soil Adjusted (May 2014)	ESV	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID				CAA06-SB32-OH02-0913	CAA06-SB33-OH02-0913	CAA06-SB39-OH02-0913
Sample Date				09/18/13	09/18/13	09/17/13
Wet Chemistry						
pH (ph)	--	--	--	5.2	5.4	5
Total organic carbon (TOC) (mg/kg)	--	--	--	5,900	5,900	4,700
Grain Size (pct)						
Coarse Sand (%)	--	--	--	NA	NA	NA
Fine Sand (%)	--	--	--	NA	NA	NA
Fines (%)	--	--	--	NA	NA	NA
Gravel (%)	--	--	--	NA	NA	NA
Medium Sand (%)	--	--	--	NA	NA	NA
GRAINSIZE (PCT/P)						
GS07 Sieve 1" (25.0 mm)	--	--	--	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	--	--	--	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	--	--	--	NA	NA	NA
Sieve No. 004 (4.75 mm)	--	--	--	NA	NA	NA
Sieve No. 010 (2.00 mm)	--	--	--	NA	NA	NA
Sieve No. 020 (850 um)	--	--	--	NA	NA	NA
Sieve No. 040 (425 um)	--	--	--	NA	NA	NA
Sieve No. 060 (250 um)	--	--	--	NA	NA	NA
Sieve No. 080 (180 um)	--	--	--	NA	NA	NA
Sieve No. 100 (150 um)	--	--	--	NA	NA	NA
Sieve No. 200 (75 um)	--	--	--	NA	NA	NA

Notes:

**Bold text indicates exceedance of CAX 95% UTL BKG SB**

Shading indicates exceedance of RSLs Residential Soil Adjusted (May 2014)

Underline indicates exceedance of ESV

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

<sup>1</sup>3-point composite subsurface soil sample

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE 4-3

Groundwater Data Exceedance Results

AOC 6 TNT Subareas Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	MCL	Adjusted Tapwater RSL (May 2014)	CAA06-MW01		CAA06-MW06	CAA06-MW02	CAA06-MW03	CAA06-MW04	CAA06-MW05
Sample ID			CAA06-GW01-1013	CAA06-GW01P-1013	CAA06-GW06-1013	CAA06-GW02-1013	CAA06-GW03-1013	CAA06-GW04-1013	CAA06-GW05-1013
Sample Date			10/02/13	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13
Chemical Name									
Total Metals (µg/l)									
Aluminum	--	2,000	50 U	50 U	50 U	19 J	48 J	50 U	50 U
Arsenic	10	0.052	5.9	6.3	33	21	33	16	26
Barium	2,000	380	15	15	14	12	8.9	25	12
Calcium	--	--	21,000	22,000	38,000	15,000 J	43,000	47,000	43,000
Cobalt	--	0.6	8.2	8.7	0.56 J	1.9	0.73 J	1	0.8 J
Cyanide	200	0.15	4 U	4 U	4 U	4 U	4 U	4 U	15.6
Iron	--	1,400	16,000	16,000	30,000	36,000 J	32,000	19,000	24,000
Lead	15	15	0.5 U	0.5 U	0.5 U	0.5 U	0.19 J	0.5 U	0.5 U
Magnesium	--	--	3,500	3,600	2,800	2,100 J	2,400	3,200	2,700
Manganese	--	43	700	710	340	220	210	400	360
Nickel	--	39	1	1.1	0.75 J	1	0.46 J	2.3	0.47 J
Potassium	--	--	1,600	1,600	2,600	1,700 J	2,100	2,800	2,500
Sodium	--	--	7,900	7,800	9,600	8,000 J	10,000	12,000	9,700
Dissolved Metals (µg/l)									
Arsenic, Dissolved	10	0.052	6	6	32	20	25	17	22
Barium, Dissolved	2,000	380	14	15	14	12	7.5	26	10
Beryllium, Dissolved	4	2.5	0.12 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Calcium, Dissolved	--	--	21,000	21,000	36,000	17,000 J	38,000	47,000	42,000
Cobalt, Dissolved	--	0.6	7.8	8.7	0.55 J	1.6	0.62 J	1.1	0.68 J
Iron, Dissolved	--	1,400	16,000	16,000	30,000	37,000 J	29,000	19,000	23,000
Magnesium, Dissolved	--	--	3,400	3,400	2,700	2,300 J	2,100	3,300	2,700
Manganese, Dissolved	--	43	670	700	330	200	170	410	280
Nickel, Dissolved	--	39	1.1	1.2	0.29 J	0.6 J	0.5 U	1.6	0.5 U
Potassium, Dissolved	--	--	1,500	1,500	2,500	1,900 J	1,800	2,800	2,400
Sodium, Dissolved	--	--	8,200	7,300	9,300	8,700 J	9,800	11,000	9,500
Vanadium, Dissolved	--	8.6	0.14 J	0.2 U	0.2 U	0.2 U	0.071 B	0.2 U	0.094 B
Zinc, Dissolved	--	600	16	5.4 B	5.3 B	4.6 B	8.4 B	2.3 B	4.3 B
Wet Chemistry									
Alkalinity (mg/l)	--	--	71	NA	120	58	120	140	130
Chloride (mg/l)	--	--	9.3	NA	9.5	10	9.5	11	11
Methane (mg/l)	--	--	2.3	NA	8.2	0.73	2.3	5.4	5.3
Nitrate (mg/l)	10	3.2	0.25 U	NA	0.25 U	0.25 U	0.095 J	0.25 U	0.25 U
pH (ph)	--	--	6.5	NA	6.5	6.4	6.4	6.7	6.6
Sulfate (mg/l)	--	--	4.6 J	NA	5 U	0.93 J	1 J	0.9 J	1.1 J
Total organic carbon (TOC) (mg/l)	--	--	2.4	NA	3.2	2.8	3.5	3	3.3

Notes:

**Bold text indicates exceedance of MCL**

Shading indicates exceedance of Adjusted Tapwater RSL

RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents

NA - Not analyzed

B - Analyte not detected significantly above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

U - The material was analyzed for, but not detected

mg/l - Milligrams per liter

µg/l - Micrograms per liter



# Legend

- ⊗ Groundwater and Surface/Subsurface Soil Sample Location – 2013 RI
- ▲ Surface/Subsurface Soil Sample Location – 2013 RI
- ▲ Surface/Subsurface/3-point Composite Soil Sample Location – 2013 RI
- ▲ Surface/Subsurface Soil Sample Location – 2008 SI
- Topographic High Point (dashed where approximated)
- Approximate AOC 6 TNT Subareas Study Boundary
- Berm Boundary
- Former TNT Graining House Sump/Former Catch Box Ruins Boundary

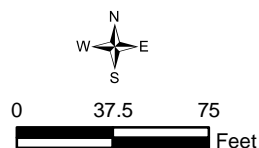
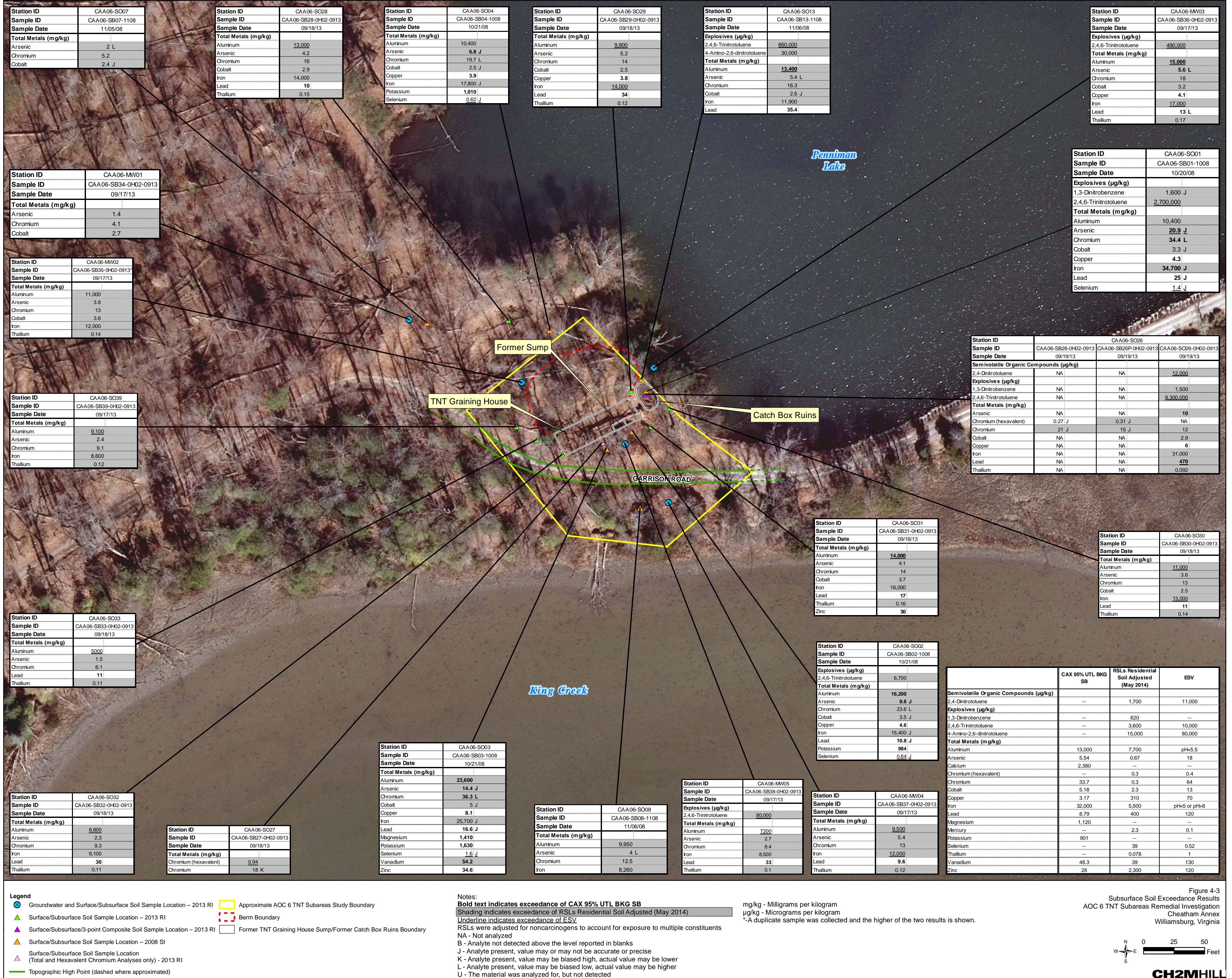


Figure 4-1  
AOC 6 TNT Subareas Comprehensive Soil Sample Locations  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia





Station ID	CAA06-MW01
Sample ID	CAA06-GW01-1013*
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	6.3
Cobalt	8.7
Iron	16,000
Manganese	710
Dissolved Metals (µg/l)	
Arsenic, Dissolved	6
Cobalt, Dissolved	8.7
Iron, Dissolved	16,000
Manganese, Dissolved	700

Station ID	CAA06-MW03
Sample ID	CAA06-GW03-1013
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	33
Cobalt	0.73 J
Iron	32,000
Manganese	210
Dissolved Metals (µg/l)	
Arsenic, Dissolved	25
Cobalt, Dissolved	0.62 J
Iron, Dissolved	29,000
Manganese, Dissolved	170

Station ID	CAA06-MW06
Sample ID	CAA06-GW06-1013
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	33
Iron	30,000
Manganese	340
Dissolved Metals (µg/l)	
Arsenic, Dissolved	32
Iron, Dissolved	30,000
Manganese, Dissolved	330

Station ID	CAA06-MW02
Sample ID	CAA06-GW02-1013
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	21
Cobalt	1.9
Iron	36,000 J
Manganese	220
Dissolved Metals (µg/l)	
Arsenic, Dissolved	20
Cobalt, Dissolved	1.6
Iron, Dissolved	37,000 J
Manganese, Dissolved	200

Station ID	CAA06-MW05
Sample ID	CAA06-GW05-1013
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	26
Cobalt	0.8 J
Cyanide	15.6
Iron	24,000
Manganese	360
Dissolved Metals (µg/l)	
Arsenic, Dissolved	22
Cobalt, Dissolved	0.68 J
Iron, Dissolved	23,000
Manganese, Dissolved	280

Station ID	CAA06-MW04
Sample ID	CAA06-GW04-1013
Sample Date	10/02/13
Total Metals (µg/l)	
Arsenic	16
Cobalt	1
Iron	19,000
Manganese	400
Dissolved Metals (µg/l)	
Arsenic, Dissolved	17
Cobalt, Dissolved	1.1
Iron, Dissolved	19,000
Manganese, Dissolved	410

	MCL	Adjusted Tapwater RSL (May 2014)
Total Metals (µg/l)		
Arsenic	10	0.052
Cobalt	--	0.6
Cyanide	200	0.15
Iron	--	1,400
Manganese	--	43
Dissolved Metals (µg/l)		
Arsenic, Dissolved	10	0.052
Cobalt, Dissolved	--	0.6
Iron, Dissolved	--	1,400
Manganese, Dissolved	--	43

- Legend**
- Groundwater and Surface/Subsurface Soil Sample Location – 2013 RI
  - Topographic High Point (dashed where approximated)
  - Approximate AOC 6 TNT Subareas Study Boundary
  - Berm Boundary
  - Former TNT Graining House Sump/Former Catch Box Ruins Boundary

Notes:  
**Bold text indicates exceedance of MCL**  
Shading indicates exceedance of Adjusted Tapwater RSL  
RSLs were adjusted for noncarcinogens to account for exposure to multiple constituents  
J - Analyte present, value may or may not be accurate or precise  
µg/l - Micrograms per liter  
\*A duplicate sample was collected and the higher of the two results is shown.

Figure 4-4  
Groundwater Exceedance Results  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia



CH2MHILL

# Human Health Risk Assessment

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## 5.1 Human Health Risk Assessment Overview

This section summarizes the AOC 6 TNT Subareas baseline HHRA, for which the primary objective was to assess the potential current and future risks to human health from exposure to COPCs associated with surface soil, surface and subsurface soil, and groundwater at the AOC 6 TNT Subareas. All of the data used in the risk assessment were fully validated, are considered useable for the HHRA, and are assumed to represent current conditions. **Table H-1 in Appendix H** lists the samples that were evaluated in the HHRA. Soil samples collected in October 2008, November 2008, and September 2013 and groundwater samples collected in October 2013 were included in the risk assessment. The analytical data are included in **Appendix G**. The baseline HHRA text and tables are presented in **Appendixes H and I**, respectively.

The HHRA evaluated the carcinogenic risks and noncarcinogenic hazards to a reasonably maximally exposed individual, which is consistent with the methodologies in risk assessment guidance for Superfund sites (USEPA 1989, 1993, 2001, 2004). The reasonable maximum exposure (RME) is the highest exposure that is reasonably expected to occur at a site (USEPA, 1989). When the RME risk exceeded target risk levels, the central tendency exposure (CTE) risk was evaluated. The CTE risk is the risk to individuals who have average or typical exposure to the environmental media.

The maximum detected concentration of each constituent for each medium was compared to the criteria discussed as follows to select COPCs for quantitative evaluation in the HHRA. If the maximum concentration exceeded any criterion, the constituent was identified as a COPC for further evaluation with respect to risk. Constituents not detected in any sample or detected at concentrations less than the criteria were not identified as COPCs. The USEPA RSLs (USEPA, 2014) were used for evaluation of media samples as follows:

- Soil – USEPA RSLs for Residential Soil (May 2014 RSL Table)
- Groundwater – USEPA RSLs for Tapwater (May 2014 RSL Table)

A CSM was developed specifically for human exposures at AOC 6 (**Figure H-1 in Appendix H**) to present an overview of site conditions, potential sources of contamination, potential contaminant-migration pathways, and potential exposure pathways to potential receptors.

## 5.2 Potential Receptors and Exposure Scenarios

Chemicals and inorganic constituents that pose a potential risk to human health may be present in site soil and groundwater. Potential current receptors exposed to these media are base workers and adult and child recreational users who may come in contact with surface soil. There is no planned future site use that is different from the current use at this time; however, future site use is unknown. Therefore, risks associated with exposure to soil and groundwater were evaluated to assess unrestricted land use, which assumes residential use as the most conservative case. In addition to evaluating hypothetical residential use (which is unlikely), potential future industrial use of the site was evaluated, which includes base workers, construction workers, and recreational users as potential future receptors.

For the future exposure scenarios, it was assumed that soil-moving activities associated with construction for future site development would result in subsurface soil being mixed with the current surface soil, resulting in subsurface soil being placed on the ground surface. Therefore, future exposure to soil was assumed to include exposure to the combined current surface and subsurface soil, so the surface and subsurface soil analytical data sets were combined together to evaluate this potential exposure. It was also conservatively assumed that groundwater from the surficial aquifer might be used as a future potable water supply; however, this is highly unlikely based on the viability of the surficial aquifer for that purpose. It is

also unlikely that shallow groundwater will be used as a potable water supply for CAX because the base municipal water is supplied by the City of Newport News Waterworks.

Since historical site use is not associated with significant VOC contamination, and volatile constituents were not found to be potential constituents of concern (COCs) during previous investigations, VOCs were not included in RI groundwater sampling analyses. Therefore, the groundwater to air pathway is not considered a complete exposure pathway.

In summary, current receptors and exposure pathways quantitatively evaluated in the HHRA are:

- **Base worker:** Incidental ingestion of and dermal contact with surface soil. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.
- **Recreational Users (adult and child):** Incidental ingestion of and dermal contact with surface soil. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.

Future receptors and exposure pathways quantitatively evaluated in the HHRA include the following:

- **Base worker:** Incidental ingestion of and dermal contact with surface and subsurface soil; ingestion of shallow groundwater. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.
- **Recreational Users (adult and child):** Incidental ingestion of and dermal contact with surface and subsurface soil. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.
- **Construction worker:** Incidental ingestion of and dermal contact with surface and subsurface soil; dermal contact with shallow groundwater in an open excavation. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.
- **Resident (adult and child):** Incidental ingestion of and dermal contact with surface and subsurface soil; ingestion of shallow groundwater, and dermal contact with shallow groundwater while bathing/showering. Inhalation of VOCs or particulate emissions from soil were not quantitatively evaluated because no COPCs were identified for this pathway.

The COPCs identified for soil and groundwater at the AOC 6 TNT Subareas, and used to calculate the RME and CTE (when calculated) noncarcinogenic hazards and carcinogenic risks, are identified in **Table H-2** in **Appendix H**. The RME noncarcinogenic hazards and carcinogenic risks are presented by receptor in **Table H-3**, and the CTE results are summarized in **Table H-4**, in **Appendix H**. The risk calculations are presented in **Tables 7.1.RME** through **7.10.RME** and **7.1.CTE** through **7.9.CTE** in **Appendix I**. The CTE risks were calculated only when the RME hazards exceeded the noncarcinogenic target hazard index (HI) of 1, or the RME carcinogenic risks exceeded the target risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  (USEPA, 1994). **Tables 9.1.RME** through **9.10.RME** and **9.1.CTE** through **9.9.CTE** in **Appendix I** summarize the hazards and risks to each receptor.

## 5.3 Human Health Risk Assessment Findings

Human health COCs are identified for the scenarios with potentially unacceptable risks. The COCs are those COPCs that contribute an HI greater than 0.1 to a cumulative target organ HI that exceeds 1 or a carcinogenic risk greater than  $1 \times 10^{-6}$  to a cumulative carcinogenic risk that exceeds  $1 \times 10^{-4}$ . The results of the risks for each receptor are summarized as follows:

- Current or Future Base Worker: Potential unacceptable noncarcinogenic hazards associated with exposure to surface soil and combined surface and subsurface soil, and potential unacceptable carcinogenic risks associated with exposure to groundwater.
  - COC for surface soil is TNT
  - COC for surface and subsurface soil is TNT
  - COC for groundwater is arsenic
- Current or Future Recreational User (adult and child): Potential unacceptable noncarcinogenic hazards associated with exposure to surface soil and combined surface and subsurface soil.
  - COC for surface soil is TNT
  - COC for surface and subsurface soil is TNT
  - Lead is not a COC when evaluating exposure to lead in soil across the full site; however, if only exposed to soil within the Catch Box Ruins, lead is a COC for Catch Box Ruins surface soil and combined surface and subsurface soil.
- Future Construction Worker: Potential unacceptable noncarcinogenic hazard associated with exposure to surface and subsurface soil. Carcinogenic risk associated with surface and subsurface soil, and noncarcinogenic hazard and carcinogenic risk associated with groundwater were within acceptable levels.
  - COC for surface and subsurface soil is TNT
- Future Resident (adult and child): Potential unacceptable carcinogenic risks and noncarcinogenic hazards associated with exposure to surface and subsurface soil and groundwater.
  - COCs for surface and subsurface soil are TNT, 2-nitrotoluene, arsenic, and hexavalent chromium.
  - COCs for groundwater are arsenic and iron
  - Lead is not a COC when evaluating exposure to lead in soil across the full site; however, if only exposed to soil within the Catch Box Ruins, lead is a COC for Catch Box Ruins surface soil and combined surface and subsurface soil.

To summarize, the COCs for AOC 6 media are as follows:

- Under Current Site Use:
  - Surface soil: TNT, plus lead within the Catch Box Ruins only
- Under Future Recreational Use:
  - Soil: TNT, plus lead within the Catch Box Ruins only
- Under Future Industrial Site Use
  - Soil: TNT
  - Groundwater: arsenic
- Under Future Residential Site Use:
  - Soil: TNT, 2-nitrotoluene, arsenic, and hexavalent chromium, plus lead within the Catch Box Ruins only
  - Groundwater: arsenic and iron

The soil COC 2-nitrotoluene was only detected in one of the thirty-nine soil samples, and the detection limits for all the other soil samples were below the human health risk-based screening level. As there was only one detected concentration, this concentration was used as the exposure point concentration to estimate the hazards and risks associated with exposure to 2-nitrotoluene. Therefore, the risks associated with exposure to 2-nitrotoluene across the site are likely over-estimated.

A comparison of site concentrations to background concentrations was not used to select the COPCs. Therefore, it is possible that any of the metals identified as COPCs and COCs may be associated with background conditions. Arsenic was identified as a COC in surface and subsurface soil. Arsenic concentrations in surface and subsurface soil ranged from 1.1 mg/kg to 20.9 mg/kg. More than half of these detections were below the 95 percent UTL from the CAX/Yorktown background values of 6.36 mg/kg and 5.54 mg/kg for surface and subsurface soil, respectively. Therefore, it is possible some of the risk associated with exposure to arsenic in soil is from background conditions.

The concentration of hexavalent chromium in subsurface soil exceeded the Residential soil RSL based on a carcinogenic risk of  $10^{-6}$ . However, this concentration would not exceed the Residential soil RSL adjusted to a carcinogenic risk of  $10^{-5}$  (3 mg/kg), indicating that the risk to a residential receptor would fall within the acceptable risk range of  $10^{-4}$  to  $10^{-6}$ . Therefore, it is unlikely there would be any adverse human health effects associated with exposure to hexavalent chromium alone in soil.

While arsenic and iron were identified as COCs in groundwater based on the quantitative HHRA, site concentrations of these constituents may be attributable to naturally occurring background conditions. Arsenic and iron concentrations are commonly found at naturally occurring concentrations that exceed human health screening criteria in shallow groundwater of the Atlantic Coastal Plain. In addition, iron is a required human nutrient. Therefore, it is unlikely there would be any adverse human health effects associated with exposure to the iron in groundwater.

The future residential land use scenario evaluated in this assessment is conservative, because it is unlikely that land use for AOC 6 will change to residential development in the future. Additionally, even if the site is used for residential development, it is unlikely shallow groundwater will be used as a potable water supply.

# Ecological Risk Assessment

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This section summarizes the results of the ERA conducted for the AOC 6 TNT Subareas. The complete ERA is contained in **Appendix J**.

## 6.1 Introduction

This ERA was conducted in accordance with the *Navy Policy for Conducting Ecological Risk Assessments* (CNO, 1999) and the Navy guidance for implementing this ERA policy (NAVFAC, 2003 and 2012). It considers data collected as part of previous evaluations of the AOC 6 TNT Subareas and data collected specifically for the RI. This ERA is completed through Step 3A of the 8-step ERA process (USEPA, 1997).

The previous ERA for the AOC 6 TNT Subareas was conducted as part of the recent SI report (CH2M HILL, 2012) and consisted of an ecological risk screening, constituting a Screening-level ERA (SERA) and an abbreviated version of Baseline ERA Step 3A. The results of the 2012 SI were used to develop the SAP for the RI (CH2M HILL, 2013). Additional surface soil, subsurface soil, and groundwater data were collected in 2013 to support the RI. The 2008 surface and subsurface soil data used in the SI were also included in this ERA. However, the 2008 groundwater data evaluated as part of the SI were not included in this ERA, since they were collected using DPT (the 2013 groundwater samples were collected from permanent monitoring wells).

## 6.2 Environmental Setting

The AOC 6 TNT Subareas, approximately 0.5 acre in size, are located near the southwestern bank of Penniman Lake (a large freshwater lake) and just north of King Creek (a tidal, estuarine water body) (**Figure 1-3**). They are composed of the remnants of the former TNT Graining House, its associated sump, and the ruins of the former TNT Catch Box. The Catch Box Ruins currently consist of an earthen, brick-lined depression located immediately east of the former TNT Graining House. The TNT Catch Box was used to separate TNT particles from wastewater associated with TNT Graining House processes. Only the concrete footprint of the former TNT Graining House currently exists on the site, as does a concrete-lined, open top pit believed to be the sump pit for the TNT Graining House. On September 19, 2013, the former TNT Graining House sump, located within the footprint of the TNT Graining House, was inspected. The concrete sump compartment measured 8 feet long, 2.5 feet wide, and 3.6 feet in depth, and contained about 2 feet of water above the bottom of the sump. Leaves, roots, and less than two inches of organic detritus, but not any residual material from former operations, were found on the bottom of the sump. Historical leaks and/or discharges from the former TNT Graining House sump and/or TNT Catch Box are the primary known/suspected sources of contamination at the AOC 6 TNT Subareas.

The AOC 6 TNT Subareas are currently wooded. Soils are somewhat acidic, with an average pH of 5.2 in surface soil and 5.4 in shallow subsurface soil. The results for TOC average just over 3 percent in surface soil, but less than 1 percent in shallow subsurface soil. Surface soil is comprised mainly of fine and medium sand, with about 10 to 20 percent silt/clay.

While the site does not contain any wetlands or water bodies, Penniman Lake is located approximately 50 feet east of the Catch Box Ruins, and King Creek is located about 100 feet south (across Garrison Road) of the remnants of the TNT Graining House (**Figure 1-3**). An earthen berm is present just north of the former TNT Graining House, rising about 15 feet above the surrounding grade. The topography on the remainder of the site is relatively flat but drops somewhat abruptly at the shoreline of Penniman Lake, and less abruptly south of Garrison Road toward King Creek (**Figure 3-1**). Surface runoff from the location of the former TNT Graining House and TNT Catch Box Ruins flows primarily east toward Penniman Lake. Due to the presence of Garrison Road, surface runoff from the locations of the former site structures is unlikely to reach King Creek. Groundwater (Columbia aquifer) was first encountered during RI sampling at a depth of about 5 to 8 feet bgs and flows primarily south toward King Creek (**Figure 3-5**) due to Penniman Lake surface water recharging

groundwater during the RI. However, during low Penniman Lake water conditions (such as in times of drought), it is possible that the groundwater flow direction could reverse such that groundwater would potentially discharge into Penniman Lake.

Navy and DoD personnel have access to the AOC 6 TNT Subareas while pursuing recreational activities such as jogging, hunting, and fishing. Future land use at the AOC 6 TNT Subareas is not expected to change and will likely continue as recreational into the foreseeable future.

## 6.3 Analytical Data Used in the ERA

Both existing surface and shallow subsurface soil (from the 2012 SI), and surface soil, shallow subsurface soil, and groundwater samples collected as part of the RI (in 2013) were quantitatively evaluated in this ERA. Since ecological exposures are generally confined to the top two feet of the soil column, the soil data used in this ERA were confined to this depth range, but were evaluated separately as surface samples (0 to 6 inches) and shallow subsurface samples (6 to 24 inches); terrestrial food web exposures only considered the surface soil samples. The results from the two surface water samples collected from Penniman Lake (in 2008) for the SI were used to represent drinking water exposures in terrestrial food web models.

Although ecological receptors do not have direct exposure to groundwater, groundwater data collected as part of the RI were also evaluated in this ERA. This was done to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to potential downgradient receiving water bodies (Penniman Lake and King Creek) and the subsequent potential exposure of ecological receptors in these water bodies. Only the groundwater data collected from permanent monitoring wells in 2013 for the RI were quantitatively evaluated in this ERA. The historical groundwater data used in the SI were not included, because they were direct-push samples.

The surface water and sediment data collected adjacent to the site (in Penniman Lake) and screened in the 2012 SI were not quantitatively evaluated in this ERA (except for the inclusion of the surface water data in the terrestrial food web models). Since Penniman Lake has now received a site designation (AOC 9), any further evaluation of surface water and sediment offshore of the AOC 6 TNT Subareas has been deferred to the Penniman Lake SI.

Background soil UTLs from the Yorktown-CAX background study (CH2M HILL, 2011) were also considered in the ERA. Because the background study does not contain background UTL values for the Columbia aquifer, two of the wells (CAA06-MW01 and CAA06-MW06; **Figure 2-1**) located upgradient of the AOC 6 TNT Subareas source areas were used to represent site-specific background conditions for groundwater. The remaining four wells were generally considered site wells.

## 6.4 Conceptual Site Model

The CSM relates potentially exposed receptor populations with potential source areas based on physical site characteristics and complete exposure pathways. Important components of the CSM are the identification of potential source areas, transport pathways, exposure media, exposure pathways and routes, and receptors. **Appendix J, Figure J-1** illustrates a diagrammatic CSM for the AOC 6 TNT Subareas. Key components of this CSM are discussed in **Appendix J. Appendix J, Table J-3** shows the assessment endpoints, risk hypotheses, and measurement endpoints used in the ERA and the receptors associated with each of these endpoints.

## 6.5 Results

### 6.5.1 Terrestrial Habitats

Ten assessment endpoints were developed for terrestrial habitats on the site (**Appendix J, Table J-3**). Lines of evidence for terrestrial habitats included:

- Comparison of surface soil and shallow subsurface soil concentrations with ESVs

- Comparison of modeled dietary doses with ingestion toxicity reference values
- Comparison of site soil concentrations with background concentrations

In surface soil, two inorganic constituents (lead and selenium) and five explosives (TNT, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-nitrotoluene, and 3,5-dinitroaniline) were identified as Step 3A COPCs for further risk evaluation. Lead was also identified as a Step 3A COPC for further risk evaluation for terrestrial food web exposures. The explosive TNT is the primary risk driver based on the magnitude of the ESV exceedances, but the extent of the exceedances is spatially limited. The highest TNT concentrations in surface soil occur in the composite sample from the former TNT Catch Box Ruins (CAA06-SO26-000H-0913). The other exceedances occur directly adjacent to the former TNT Catch Box Ruins to the east and south (samples CAA06-SS01-1008, CAA06-SS13-1108, and CAA06-SS36-0913) and in the vicinity of the former sump (samples CAA06-SS38-0913 and CAA06-SS02-1008). There were no detections of the other four explosive COPCs (which lacked ESVs) in any sample that did not also have an exceedance of the TNT ESV. Similarly, the two highest concentrations of lead in surface soil occurred in the two samples with the highest TNT concentrations. Thus, spatially limited risks associated with lead may occur for lower trophic level receptors. Although the 95 percent upper confidence level (UCL) concentration of lead in surface soil resulted in hazard quotients (HQs) in excess of 1 based on the Maximum Acceptable Toxicant Concentration for the shrew and mourning dove, there were no exceedances based on the mean concentration. Thus, given the very limited spatial area with elevated lead concentrations, potential risks for upper trophic level receptors from food web exposures are likely to be low. Selenium exceeded ESVs and background UTLs in only two surface soil samples and did not follow the spatial pattern of lead and TNT. The 95 percent UCL HQ was just over 1 (1.05). Thus, potential risks associated with selenium are low and do not appear to be site-related.

In summary, the primary risk drivers in surface soil are TNT and lead, but the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas.

In shallow subsurface soil, three inorganic constituents (hexavalent chromium, lead, and selenium) and five explosives (TNT, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 4-nitrotoluene, and 3,5-dinitroaniline) were identified as COPCs for further risk evaluation. The explosive TNT is the primary risk driver, based on the magnitude of the ESV exceedances, but, as with surface soil, the extent of the exceedances is spatially limited. The highest TNT concentrations in shallow subsurface soil occur in the composite sample from the former TNT Catch Box Ruins (CAA06-SO26-0H02-0913). The other exceedances occur directly adjacent to the former TNT Catch Box Ruins to the east and south (samples CAA06-SB01-1008, CAA06-SB13-1108, and CAA06-SB36-0H02-0913) and in the vicinity of the former sump (CAA06-SB38-0H02-0913). There were no detections of the other four explosive COPCs (which lacked ESVs) in any sample that did not also have an exceedance of the TNT ESV except for CAA06-SB03-1008, which had a low detection (28 µg/kg) of 1,3-dinitrobenzene. Similarly, the highest concentration of lead in shallow subsurface soil (and the only ESV exceedance) occurred in the sample with the highest TNT concentration. Thus, spatially limited risks associated with lead may occur for lower trophic level receptors. Selenium exceeded background UTLs in only three shallow subsurface soil samples and did not follow the spatial pattern of lead and TNT. While the 95 percent UCL HQ was over 1 (1.62), the mean HQ did not exceed 1 (0.92). Thus, potential risks associated with selenium are low and do not appear to be site-related. Although hexavalent chromium exceeded its ESV in a single sample, there were no ESV exceedances for total chromium and total chromium concentrations were at or below background levels. Thus, potential risks associated with chromium are not significant.

In summary, the primary risk drivers in shallow subsurface soil are TNT and lead, but, as with surface soil, the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas.

## 6.5.2 Aquatic Habitats

Potential aquatic exposures in Penniman Lake adjacent to the AOC 6 TNT Subareas will be evaluated as part of the Penniman Lake investigation. This ERA looked at the potential for off-site transport via groundwater to downgradient water bodies (Penniman Lake and King Creek). No chemical detected in site groundwater, except dissolved barium and dissolved iron, exceeded both its ESV and its background concentration. Dissolved iron exceeded its freshwater ESV (there was no marine ESV) by a factor of 27 based on the mean concentration. Thus, the mean HQ would exceed 1 even assuming a dilution factor of 10. The mean concentration of dissolved barium exceeded its freshwater (but not marine) ESV by a factor of less than 4. Thus, the mean HQ would be below 1 assuming a dilution factor of 10. However, the concentrations of dissolved barium and dissolved iron were not highly elevated relative to background concentrations, exceeding background in only 1 of the 4 site wells at maximum ratios of 1.73 and 1.23, respectively. The one background exceedance for barium was in CAA06-MW04, located south of Garrison Road near King Creek. King Creek is an estuarine water body and dissolved barium did not exceed its marine ESV. Thus, these two inorganic constituents do not appear to be site-related (neither one was a COPC in site soil) nor do they appear to be present at concentrations that would present a potential risk to aquatic receptors above background levels.

Cyanide also exceeded both its freshwater and marine ESV in one sample (CAA06-GW05-1013). The ESVs for cyanide are based on free (bioavailable) cyanide, not total cyanide, while the measured groundwater concentrations are for total cyanide. Only a small fraction of the total cyanide will be present in bioavailable forms. The mean HQ (undiluted) was slightly greater than 1 (1.04) based on the freshwater ESV and exceeded 1 (5.40) based on the marine ESV. Assuming a dilution factor of 10, the mean HQ is below 1 even if it is assumed that all of the cyanide is present in bioavailable forms. Cyanide was not a soil COPC and does not appear to be site related.

Based on the results of this evaluation, groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.

## 6.6 ERA Summary and Conclusions

In summary, the primary ecological risk drivers in surface and shallow subsurface soil are TNT and lead (**Appendix J, Table J-31**), but the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas. Based on the results of this evaluation, groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.

# Chemical Fate and Transport

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This section discusses the fate and transport of soil and groundwater COCs identified from the HHRA and ERA (**Sections 5 and 6**, respectively) for the AOC 6 TNT Subareas. Surface water and sediment media were not evaluated since they are being assessed as part of the Penniman Lake SI. Fate and transport consists of the identification of theoretical chemical phases and migration and degradation pathways. An understanding of the mobility and persistence of a constituent in the subsurface is part of the overall assessment of the potential for that constituent to cause an adverse human health or environmental effect. As shown in **Table 7-1**, the COCs for the AOC 6 TNT Subareas include explosives and inorganic constituents in soil and inorganic constituents in groundwater. However, the concentrations of the inorganic constituent COCs in groundwater within the AOC 6 TNT Subareas were found to be attributable to naturally occurring background conditions.

Fate and transport characteristics for each group of COCs are described as follows. Chemical properties are listed in **Table 7-2**.

This section also presents and summarizes the overall CSM for the AOC 6 TNT Subareas, which was developed using the compendium of information and data presented in this RI report, including the fate and transport discussion in this section.

## 7.1 Chemical Mobility and Persistence

The mobility and persistence of the potential contaminants at the site are determined by their physical, chemical, and biological interaction with the environment. Mobility is the potential for a chemical to migrate from a site, and persistence is a measure of how long a chemical will remain in the environment. Because environmental conditions are an important factor, predicting contaminant behavior and migration can sometimes be difficult. Some of the mechanisms controlling mobility and persistence are described as follows.

### 7.1.1 Volatilization

Volatilization occurs when a compound transfers from the aqueous phase to the gas phase. Measures of a chemical's tendency to volatilize from water and soil include its vapor pressure and  $K_h$ . Compounds with  $K_h$  values higher than  $10^{-3}$  atmospheres per cubic meter per mole ( $\text{atm}\cdot\text{m}^3/\text{M}$ ) are expected to volatilize readily from water to air, whereas those with  $K_h$  values lower than  $10^{-5}$   $\text{atm}\cdot\text{m}^3/\text{M}$  are relatively non-volatile. Compounds with  $K_h$  values in between these values are expected to be moderately volatile. At a given temperature, the higher the vapor pressure of a compound, the higher the volatility of that compound.

Volatilization tends to occur more readily from shallow soil than from deeper soil or groundwater. In groundwater, volatilization can occur only at the air/water interface between the saturated and unsaturated zones, and movement of aqueous-phase contaminants from bulk groundwater to the interface is largely diffusion-limited. In unsaturated shallow soil, the soil gas pressure generally approximates the ambient air pressure. With depth, the soil gas pressure tends to increase, and it becomes more difficult for the gas to escape and equalize with the ambient air pressure.

Values of vapor pressure and  $K_h$  for the site COCs are provided in **Table 7-2**. The  $K_h$  values indicate that 2-nitrotoluene has moderate volatility, while TNT has very limited volatility. Due to the complexity of inorganic constituents and their variable forms in the environment, no  $K_h$  values can be provided for inorganic constituents. However, these constituents are typically not volatile under normal temperature and pressure conditions. Emissions to ambient air are usually in the form of particulates mobilized by wind.

### 7.1.2 Sorption

Sorption occurs when a constituent adheres to and becomes associated with solid particles in the geologic formation. The subsurface materials likely to sorb chemicals are clays and organic matter. Silty clay is present in the Yorktown confining unit. In addition, some inorganic constituents, such as arsenic species, can sorb to iron and oxyhydroxide or oxide coatings on soil and sediment grains.

The conventional measure of sorption is the distribution coefficient ( $K_d$ ). The  $K_d$  for organic chemicals is the product of the soil organic carbon partition coefficient ( $K_{oc}$ ) of the chemical and the fraction of organic carbon ( $f_{oc}$ ) in the soil. Based on site-specific TOC data (**Table 4-2**), the  $f_{oc}$  content in AOC 6 subsurface soil is estimated at 0.006. In general, chemicals with a  $K_{oc}$  greater than 10,000 milliliters per gram (ml/g) have high degrees of adsorption and consequentially low mobility, whereas chemicals with a  $K_{oc}$  lower than 1,000 ml/g have lower degrees of adsorption and consequentially higher mobility. The explosive TNT has a moderate  $K_{oc}$  value, whereas 2-nitrotoluene has a low  $K_{oc}$  value. Sorption of TNT can increase with higher pH conditions and temperature (United States National Library of Medicine, 2011). It may also be slow to desorb.

The  $K_d$  for inorganic constituents is a complex function of pH, organic content, oxide coatings, and other factors; therefore,  $K_d$  is not easily estimated by methods other than site-specific testing. Due to the number of factors that impact the  $K_d$  values for inorganic constituents, these values range from 0.2 mL/g to 100,000 mL/g (**Table 7-2**). Generally, inorganic constituent adsorption increases with pH. Inorganic constituents most often sorb to clay minerals, organic matter, and iron and manganese oxyhydroxides. Inorganic constituents may be sorbed on the surface of the soil or fixed to the interior of the soil, where they are unavailable for release to groundwater. After available sorption sites are filled, most inorganic constituents are incorporated into the structures of major mineral precipitates as co-precipitates.

### 7.1.3 Solubility

Solubility is a measure of the degree to which a constituent will dissolve in water. Highly soluble chemicals are more likely to be leached from soil by precipitation or runoff that infiltrates into the subsurface. The two explosives (TNT and 2-nitrotoluene) have moderate water solubilities (**Table 7-2**).

The solubilities of inorganic constituents are dependent on several factors and are, therefore, not included in **Table 7-2**. In general, solubility is highly dependent on the oxidation state of the inorganic constituent, which is dependent on subsurface conditions. The solubility of cations decreases as pH increases. Some cations may form complexes with oxygen and hydroxide, forming insoluble oxyhydroxides, or with phosphate, sulfate, and carbonate, forming insoluble mineral precipitates. Inorganic sulfide complexes, which form in reducing environments, are extremely insoluble and tend to reduce the total inorganic constituent concentrations (USEPA, 1979).

### 7.1.4 Bioaccumulation

Bioaccumulation is the extent to which a chemical will partition from water into the lipophilic parts (such as fat) of an organism. Bioaccumulation commonly is estimated by the octanol-water partition coefficient ( $K_{ow}$ ). Chemicals with high values of  $K_{ow}$  tend to avoid the aqueous phase and remain in soil longer or bioaccumulate in the lipid tissue of exposed organisms. Accumulation of a chemical in the tissue of the organism can be quantified by a bioconcentration factor (BCF), which is the ratio of the concentration of the chemical in the tissue to the concentration in the water. The BCFs are both contaminant-specific and species-specific.

**Table 7-2** lists some bioaccumulation values for the COCs. The explosive 2-nitrotoluene had the highest value. Bioaccumulation values for the other explosives were an order of magnitude lower. It is assumed that for an inorganic constituent to be taken up by a plant or to exert an effect on plant growth, it must be present in solution. Therefore, factors that influence the speciation and solubility of inorganic constituents in soil also affect bioconcentration. The pH of soil can also affect the amount of plant uptake of certain elements.

### 7.1.5 Transformation

Transformation occurs when the valence state of inorganic constituents is increased (oxidation) or decreased (reduction). It can be caused by changes in oxidation potential and/or pH and by microbial or non-microbial (abiotic) processes. Transformation may have a significant effect on the mobility of an inorganic constituent, either increasing or decreasing it.

The solid form of iron (iron hydroxides) is usually present in the natural soil matrix. If sufficient amounts of oxygen and nitrate are not present in the subsurface, iron hydroxides will be used as electron acceptors by metabolic activity and reductively dissolve into soluble forms. Sulfides present in groundwater can also reductively dissolve iron hydroxides. Several inorganic constituents (such as, arsenic) have a tendency to sorb to iron hydroxides. If these compounds are reductively dissolved, then the inorganic constituents that are bound to these hydroxides and oxides will also be released.

In oxidizing environments, arsenic and chromium primarily exist as oxyanions (hard anions that contain oxygen) and are relatively mobile. They can be adsorbed by clays, iron hydroxides, aluminum hydroxides, manganese compounds, and organic material at acidic and neutral pHs. Arsenic and chromium can be reduced from higher to lower valence states by organic matter, divalent inorganic constituents, and dissolved sulfide. Under reducing conditions, insoluble arsenic sulfides are precipitated in the presence of sulfides. Chromium will form insoluble chromium hydroxide or be sorbed by manganese oxides.

Lead forms insoluble inorganic sulfides in anaerobic environments. It tends to sorb and will be transported in water primarily with suspended colloidal particles (Eastern Research Group, 2003). Lead is relatively immobile in all matrices due to its strong tendency to be sorbed by iron and manganese oxides and the insolubility of many lead minerals.

### 7.1.6 Degradation

Degradation is the deterioration or destruction of a chemical either biologically (biodegradation) or abiotically through such processes as hydrolysis and photolysis. Biodegradation of chemicals by microbial organisms occurs through metabolic or enzymatic processes. Hydrolysis is the reaction of a chemical with water and photolysis is the result of exposing the chemical to light. The rate of degradation is dependent on the existing chemical, biological, and physical conditions of the medium in which the contaminant is located.

Two explosives have been identified as COCs at the AOC 6 TNT Subareas (TNT and 2-nitrotoluene). The explosive TNT can be aerobically biodegraded or anaerobically reduced by hydrogen, and it can also be co-metabolized. Nevertheless, degradation processes in soil can be slow and very high concentrations may be toxic to microorganisms. Anaerobic reduction would be expected to have the fastest degradation rate and result in several degradation products, including 2-amino and 4-amino DNT and azoxydimers. Another consideration is TNT is also subject to abiotic photolysis, where trinitrobenzene and trinitrobenzaldehyde are possible photolytic degradation products. 2-Nitrotoluene can be biodegraded via aerobic and anaerobic processes. The biodegradation of 2-nitrotoluene is very slow in unacclimated soil environments. 2-Nitrotoluene can potentially degrade via abiotic photolysis; however, it is not likely to undergo hydrolysis in the natural environment (United States National Library of Medicine, 2011).

### 7.1.7 Natural Attenuation Evaluation

Geochemical and general water quality parameters were measured during the RI to help evaluate natural attenuation processes in groundwater. The COCs identified in groundwater at the AOC 6 TNT Subareas include two inorganic constituents: arsenic and iron. However, the concentrations of these constituents were found to be attributable to naturally occurring background conditions.

Natural attenuation includes a variety of physical, chemical, or biological processes that under favorable conditions act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. These processes consist of biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants.

Geochemical data are provided in **Tables 2-3** and **4-3** and can be used to assess the potential speciation of inorganic constituents. Physical attenuation processes can also be important. Sorption was discussed in **Section 7.1.2** while volatilization was discussed in **Section 7.1.1**.

In the Columbia aquifer, groundwater is under slightly anaerobic and more reducing conditions. The DO concentrations were typically measured below 0.5 mg/L. In the lateral cross/upgradient well (CAA06-MW01), the ORP value was measured at -53 mV. The ORP values were measured below -100 mV in the remainder of site monitoring wells, including monitoring wells CAA06-MW02 and CAA06-MW06, which are also located cross gradient of the former TNT Graining House and Catch Box Ruins, meaning they are not located downgradient of the source areas. In fact, groundwater from CAA06-MW06 had the most negative ORP value of all the monitoring wells present at the site. Monitoring well CAA06-MW04, which is located in the downgradient portion of the site, had the second lowest measured ORP value. Consistent with these low ORP values, groundwater from monitoring wells CAA06-MW04 and CAA06-MW06 also had the strongest geochemical indicators for biological reactions that proceed under more reduced conditions, thus, higher ferrous iron concentrations (iron reduction) and methane concentrations (methanogenesis). Sulfate concentrations in groundwater were also observed to be lower in downgradient monitoring wells, which may be indicative of sulfate reduction. The pH values were relatively neutral (greater than 6) across the aquifer.

The more reducing conditions observed in the Columbia aquifer at the AOC 6 TNT Subareas can impact inorganic constituent concentrations. Under these conditions, the solid forms of iron (iron hydroxides) and manganese (manganese oxides), which are usually present in the natural soil matrix, can reductively dissolve into soluble forms. Any inorganic constituents (such as, arsenic) that may be naturally bound to these hydroxides will also be released to groundwater. At the AOC 6 TNT Subareas, total and dissolved arsenic and iron concentrations were higher in monitoring wells with ORP values less than -100 mV in comparison to CAA06-MW01 (-53 mV).

## 7.2 Contaminant Migration

The following subsections present a generalized description of theoretical contaminant flow pathways at the AOC 6 TNT Subareas that may have resulted in the distribution of contaminants. Potential exposure and receptor pathways were discussed in Sections 5 and 6.

### 7.2.1 Unsaturated Zone Migration

Contaminants released to surface soil may have migrated vertically into subsurface soil through gravitational force or leaching from infiltration. Additionally, the former TNT Graining House sump was located bgs in a concrete pit. If there were cracks within the pit, a release may have been made directly to subsurface soil. The concrete foundation of the former TNT Graining House still exists at the site and should prevent infiltration where it is competent. Otherwise, the AOC 6 TNT Subareas are wooded and moderately vegetated with shrubs, providing limited to no restriction for infiltration. However, the vegetation should limit wind erosion and volatilization, which could release contaminants in surface soil to the atmosphere. The vegetation may also limit surface soil transport via surface runoff during storm events. Once in the unsaturated zone, contaminants may have sorbed to soil or organic matter, become trapped in residual pore spaces, or continued to leach and be transported to the saturated zone.

Only two explosives (TNT and 2-nitrotoluene) were identified as COCs in surface and subsurface soil at the site. The explosive TNT has a low mobility in soil based on its moderate sorption potential, slow desorption, and low volatility, while 2-nitrotoluene is considered to be more mobile in soil with its low sorption potential and moderate solubility. Because 2-nitrotoluene has moderate volatility, it may volatilize into the atmosphere and soil gas. The explosives are subject to aerobic and anaerobic biodegradation; however, anaerobic biodegradation may be faster. Therefore, biodegradation of these constituents may be slow in surface soil, which is considered to be aerobic due to its proximity to the atmosphere. If exposed to direct sunlight, contaminants in surface soil would be subject to abiotic photolysis.

Only three inorganic constituents were identified as either human health or ecological COCs in soil at the site. This includes lead (ecological COC) in surface soil and arsenic and hexavalent chromium (human health COCs) in combined surface/subsurface soil. The mobility of inorganic constituents in the unsaturated zone is highly dependent on the subsurface conditions. Assuming that the soil at the AOC 6 TNT Subareas exists under more oxidizing conditions, arsenic and chromium are typically present in forms that are more mobile. However, these inorganic constituents, along with lead, will potentially sorb or complex with clays, organic material, iron hydroxides, or manganese oxides, limiting their mobility. Only a small fraction of lead in soil will be in a water-soluble form.

## 7.2.2 Saturated Zone Migration

Iron and arsenic are the only COCs identified in groundwater at the AOC 6 TNT Subareas. Contaminants can enter groundwater by leaching through unsaturated zone soil. However, elevated concentrations of these inorganic constituents are likely the result of reductive dissolution of the naturally occurring mineralogy in the subsurface. Dissolved contaminants can be transported in groundwater through advection and dispersion. Advection is the primary transport mechanism and includes the transport of dissolved contaminants by the bulk motion of flowing groundwater. Dispersion is the spreading of dissolved contaminants from the path they would be expected to follow during advection due to the spatial variation in aquifer permeability, fluid mixing, and molecular diffusion.

At the AOC 6 TNT Subareas, groundwater in the Columbia aquifer has an overall flow direction of south-southwest towards King Creek. The estimated horizontal groundwater velocity of 0.022 ft/day at the site is relatively slow. Although no vertical hydraulic gradient data are available, the Penniman Lake surface water elevation measured during the August 2014 gauging event was over 1.5 feet higher than groundwater elevations measured at the site. This indicates that Penniman Lake is recharging the surficial aquifer at the AOC 6 TNT Subareas. It is possible that there may be times when groundwater discharges into the surface water body (such as, in times of drought).

Contaminants typically will not move as rapidly as groundwater because of retardation or the adsorption of the contaminant to the solid media. The advective migration rates of different dissolved contaminants vary depending on the  $K_d$  and the rate of groundwater flow. For each contaminant detected at the site, it is theoretically possible to calculate a retardation coefficient, which is an estimate of the degree to which the contaminant is slowed by adsorption in relation to the groundwater flow velocity. The retardation coefficient is calculated according to the following equation:

$$R = 1 + p_b \times K_d / n_e$$

Where :

$R$  = Retardation coefficient (dimensionless)

$p_b$  = Bulk density (grams per cubic centimeter [ $\text{g}/\text{cm}^3$ ])

$K_d$  = Distribution coefficient ( $\text{ml}/\text{g}$ )

$n_e$  = effective porosity (dimensionless)

Assuming a bulk density of  $1.5 \text{ g}/\text{cm}^3$  and an effective porosity of 0.3, the estimated retardation coefficients are listed in **Table 7-2**. Retardation coefficients for inorganic constituents are variable depending on the form of the chemical in the subsurface and may range from 8 to 100,000 for arsenic and iron. The effect of retardation is estimated by dividing the groundwater flow velocity by  $R$ , which provides a value of migration that is either equal to (in the case of no retardation) or less than (in the presence of retardation) the groundwater flow velocity (**Table 7-2**).

Transport and partitioning of inorganic constituents in water is dependent on the oxidation state of the constituent and on interactions with other materials present. Under the more reducing conditions generally observed in the Columbia aquifer at the site, iron will be transformed into its more soluble form. Any inorganic constituent (such as, arsenic) that may be naturally bound to iron hydroxides and manganese oxides can also become more mobile. If sulfides are present in groundwater, arsenic may co-precipitate.

## 7.3 Conceptual Site Model Summary

This subsection summarizes the CSM for the AOC 6 TNT Subareas, which qualitatively combines and interprets site-specific physical characteristics (such as, hydrogeology), contaminant sources, nature and extent of contamination, potential migration of the contaminants, and the potential exposure and receptor pathways. **Figure 7-1** provides a graphical depiction of the CSM and supports the discussion in this section. The CSM is a living document used to support potential risk management decisions and aid in defining the effectiveness of potential remedial alternatives, if needed.

### 7.3.1 Physical Characteristics

The AOC 6 TNT Subareas are a 0.5-acre section of CAX, which includes the former TNT Graining House Sump and TNT Catch Box Ruins. The concrete foundation of the former TNT Graining House still exists and also includes three separate pits, or vaults, below the level of the foundation. This area is surrounded by an earthen berm. The depression for the former TNT Catch Box Ruins is located to the east of the concrete foundation; however, bricks, which supposedly lined the depression, were not observed during the most recent site visits. Penniman Lake is located to the north and east of the site and Garrison Road and King Creek are located to the south of the site. Garrison Road is a topographic high point (**Figure 1-3**) and the ground topography slopes away from the road on both sides with a steeply decreasing grade towards the shoreline of Penniman Lake. Therefore, overland flow during storm events is likely directed towards the lake. Other than the concrete foundation, the AOC 6 TNT Subareas are wooded and moderately vegetated with shrubs, providing limited restriction for infiltration to the subsurface. Garrison Road is gravel-covered.

At the AOC 6 TNT Subareas, the subsurface lithology consists primarily of silty sand, which is underlain by a fat clay. A silty, sandy clay layer is observed within the silty sand. The TOC content is considered to be moderate, with an average  $f_{oc}$  of 0.006 in subsurface soil, and could facilitate sorption of some constituents.

The groundwater aquifer of interest is the shallow, unconfined Columbia aquifer, which is underlain by the Yorktown confining unit. The depth to groundwater ranges between 5 and 8 feet bgs. Groundwater in the Columbia aquifer generally flows to the south-southwest towards King Creek at an estimated groundwater velocity of 0.022 ft/day (8 feet per year). During the August 2014 groundwater gauging event, the surface water elevation of Penniman Lake was higher than groundwater elevations beneath the AOC 6 TNT Subareas. This suggests that the lake is recharging the shallow aquifer in this area of CAX, resulting in a groundwater flow direction away from the lake. However, during low Penniman Lake surface water conditions (such as, in times of drought), it is possible that the groundwater flow direction could reverse such that groundwater would potentially discharge into the lake.

### 7.3.2 Potential Sources of Contamination and Migration Pathways

The sources of contamination at the AOC 6 TNT Subareas are considered to be potential historical leakage or discharge from the former TNT Graining House Sump and/or TNT Catch Box Ruins. The former TNT Catch Box Ruins were used to separate TNT particles from wastewater. The primary potential migration pathways of COCs in the site media are:

- Leaching of contaminants from impacted surface soil into subsurface soil
- Dissolved contaminant migration in the Columbia aquifer with groundwater flow (via advection and dispersion)

Less prominent fate and transport mechanisms which may be active at the AOC 6 TNT Subareas include volatilization of surface soil contaminants into the atmosphere, stormwater runoff of surface soil contaminants towards Penniman Lake, and leaching of contaminants from subsurface soil into groundwater.

### 7.3.3 Distribution and Transport of COCs

Two explosives (TNT and 2-nitrotoluene) were identified as COCs in surface and subsurface soil at the site. In surface soil and subsurface soil, the highest concentrations of TNT were observed in samples collected

within the former TNT Catch Box Ruins. Elevated concentrations were also detected in soil to the north/northeast of the former TNT Catch Box Ruins and to the southeast of the former TNT Graining House. Concentrations of explosives were observed to decrease sharply over a horizontal distance. For example, there were no detections of explosives in surface soil sample CAA06-S229-0913, even though it is only 20 feet from surface soil samples CAA06-SS13-1108 (TNT: 51,000 µg/kg) and CAA06-SS01-1008 (TNT: 4,500,000 µg/kg). In general, concentrations of TNT were lower in subsurface soil in comparison to co-located surface soil. The only exception to this was observed at sample location CAA06-SO13, located outside the northern edge of the former TNT Catch Box Ruins; subsurface soil concentrations were an order of magnitude higher than surface soil concentrations. The highest concentrations of 2-nitrotoluene were detected at the southeast corner of the former TNT Graining House. However, 2-nitrotoluene was not detected in subsurface soil. The TNT constituent is considered to have low mobility in soil, while 2-nitrotoluene is considered to be more mobile. However, no explosives have been detected in groundwater. Therefore, these contaminants are not leaching to groundwater.

Inorganic constituents were identified as COCs in soil and groundwater. The mobility of inorganic constituents is highly dependent on the subsurface conditions, which influences the oxidation state of the inorganic constituent and interactions with other materials present. At the AOC 6 TNT Subareas, pH values in soil are slightly acidic (surface soil is pH is typically below 5.5 and subsurface soil pH is typically below 6.0). The ORP levels and DO concentrations in groundwater suggest a more reducing environment.

- Lead was identified as a COC in surface soil. The highest surface soil concentrations were observed at the former TNT Catch Box Ruins. Concentrations in sample CAA06-SO26-000H-0913 (1,100 mg/kg) were two orders of magnitude higher than the background concentration of 17.4 mg/kg. Elevated concentrations of lead were also observed to the southeast of the former TNT Graining House and just north of the former TNT Catch Box Ruins. Lead is relatively immobile in soil due to its strong tendency to be sorbed by iron and manganese oxides and the insolubility of many lead minerals. As a result, subsurface soil concentrations were an order of magnitude lower than the co-located surface soil samples.
- Hexavalent chromium was identified as a COC in combined surface/subsurface soil. However, there was only one surface soil sample (CAA06-SS03-1008) with a total chromium concentration (34.7 mg/kg) greater than the background value of 18.2 mg/kg. In subsurface soil, two samples were analyzed for hexavalent chromium (CAA06-SS26-0913 and CAA06-SS27-0913). Although the total chromium concentration in each of these subsurface soil samples was below the background value of 33.7 mg/kg, the hexavalent chromium concentration in sample CAA06-SS27-0913 was reported above its residential RSL and ESV. Total chromium subsurface soil concentrations were similar to, or slightly higher than, the co-located surface soil concentrations. While chromium may be more mobile under oxidizing conditions, it readily complexes with clays, organic material, iron hydroxides, or manganese oxides, limiting its mobility.
- Arsenic was identified as a COC in combined surface/subsurface soil. Arsenic was detected at its highest concentrations in surface soil located just south of the former TNT Graining House Sump and in subsurface soil located at the former TNT Catch Box Ruins. Arsenic concentrations in surface soil were generally similar to, or slightly lower than, subsurface soil concentrations. As with chromium, arsenic may be more mobile under oxidizing conditions; however, it readily complexes with clays, organic material, iron hydroxides, or manganese oxides, limiting its mobility.
- Arsenic and iron were identified as COCs in groundwater. However, elevated arsenic and iron concentrations are attributed to naturally occurring background conditions reflective of the natural reductive dissolution process rather than the result of a CERCLA release. Arsenic, which is typically bound to iron hydroxides and manganese oxides, can be released into groundwater under reducing conditions as iron and manganese are transformed into forms that are more mobile. Monitoring wells CAA06-MW01, -MW02, -MW06 are located upgradient or sidegradient of the suspected release areas

(former TNT Graining House and TNT Catch Box Ruins) and in areas with soil concentrations below the background UTLs. Therefore, groundwater from these wells is considered to be representative of the range of background concentrations present in this area of CAX. Both arsenic and iron concentrations in monitoring wells located adjacent to or downgradient of the suspected release areas were all below the ranges of representative background values.

#### **7.3.4 Risk Receptors**

Future land use at the AOC 6 TNT Subareas is not expected to change and will likely continue as wooded/recreational in the foreseeable future. Groundwater at CAX is not a current or anticipated source of potable drinking water. However, the Commonwealth of Virginia does not employ groundwater use classifications; therefore, groundwater at CAX is considered to be of potential beneficial use.

The only current human receptors at the site are base workers and adult and child recreational users. There are unacceptable human health risks to all current receptors and future receptors (current receptors, construction workers, and residents) from potential exposure to contaminants in soil and groundwater. There are unacceptable risks to ecological receptors from exposure to surface soil and subsurface soil.

TABLE 7-1

## Constituents of Concern By Medium

*AOC 6 TNT Subareas Remedial Investigation**Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Medium			
	Surface Soil	Subsurface Soil	Combined Soil	Groundwater
<b>Explosives</b>				
2,4,6-Trinitrotoluene	HE	E	H	
2-Nitrotoluene	E		H	
<b>Metals</b>				
Arsenic			H	H
Chromium, Hexavalent			H	
Iron				HE
Lead	E			

Notes:

E - Ecological COC

H - Human Health COC

TABLE 7-2

## Physical and Chemical Properties for Constituents of Concern

## AOC 6 TNT Subareas Remedial Investigation

## Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Molecular Weight (g/mole)	Density (g/cm <sup>3</sup> )	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	K <sub>h</sub> (atm-m <sup>3</sup> /mole)	K <sub>oc</sub> (---)	K <sub>d</sub> (mL/g)	R (---)	V <sub>c</sub> (ft/yr)	Log K <sub>ow</sub> (---)	Log BCF (---)
<b>Explosives</b>											
2,4,6-Trinitrotoluene	227.1	1.65	115	8.02E-06	2.10E-08	1600	9.6	49	0.16	1.60	0.53
2-Nitrotoluene	137.1	1.16	650	1.85E-01	1.25E-05	370	2.2	12	0.66	2.30	1.18
<b>Metals</b>											
Arsenic	74.92	5.78	U	U	U	NA	2.0 - 20,000	11 - 100,000	0.00008 - 0.7	U	U
Chromium	52.00	7.14	U	U	U	NA	0.20 - 63,000	2 - 315,000	0.00003 - 4.0	U	U
Iron	55.85	7.87	U	U	U	NA	1.4 - 10,000	8 - 50,000	0.00016 - 1.0	U	U
Lead	207.2	11.34	U	U	U	NA	5.0 - 100,000	26 - 500,000	0.00002 - 0.3	U	U

## Notes:

BCF = Bioconcentration Factor

foc = fraction organic carbon = 0.006 (average of total organic carbon subsurface soil data)

K<sub>d</sub> = Soil-Water partition coefficient = K<sub>oc</sub> x foc for organicsK<sub>h</sub> = Henry's Law ConstantK<sub>oc</sub> = Organic carbon partition coefficientK<sub>ow</sub> = Octanol-water partition coefficient

NA = no information available

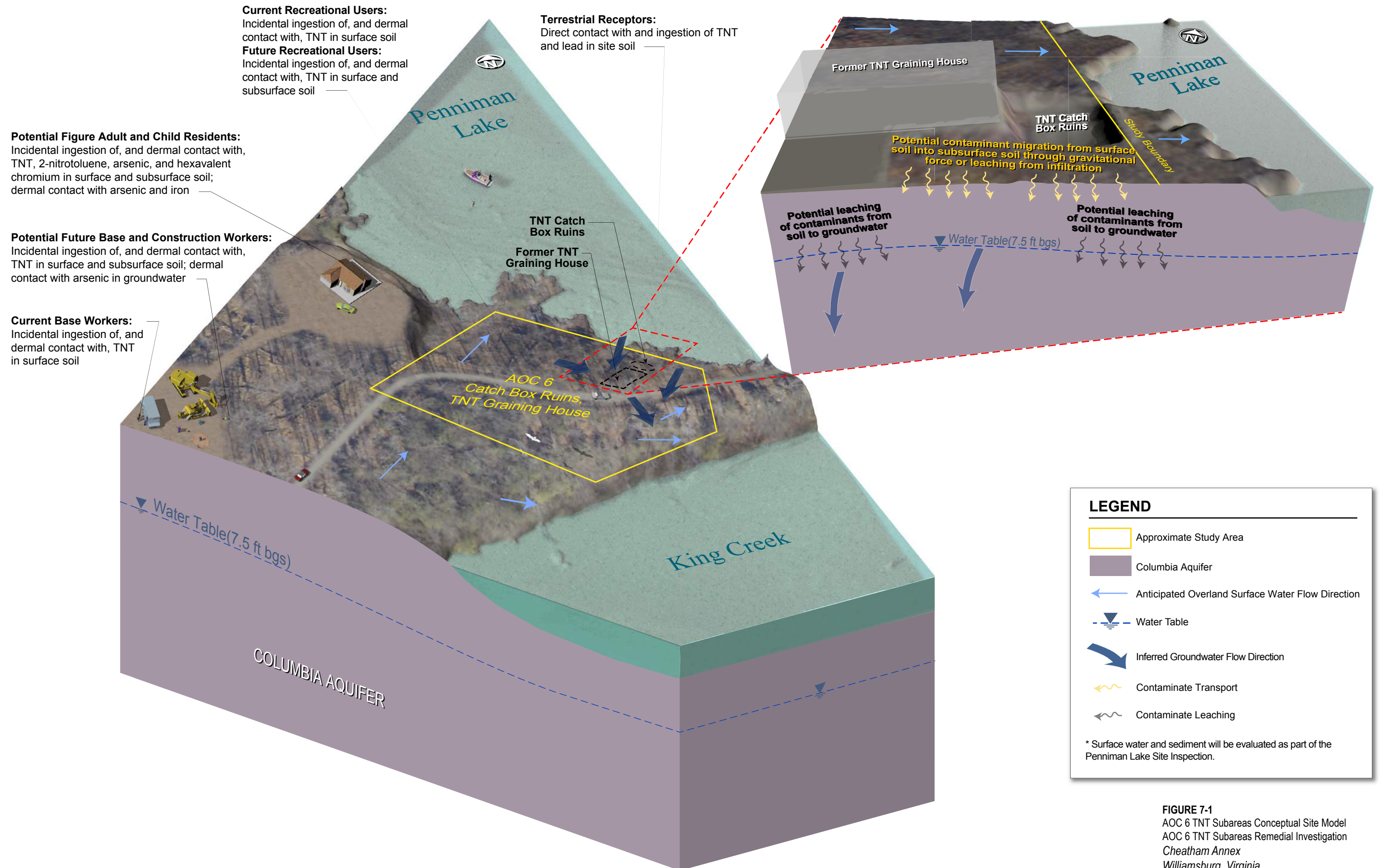
n<sub>e</sub> = Effective porosity = 0.30 (estimate)R = Retardation coefficient =  $1 + K_d \times \rho_b / n_e$  $\rho_b$  = Soil bulk density = 1.5 grams per cubic centimeter (sandy loam)

U = No value is provided because of the uncertainty in the form of these chemicals in the environment

V<sub>c</sub> = Contaminant velocity = seepage velocity (estimated at 0.022 ft/day) / R; velocity calculations included in Section 3 of the RI report

## Data sources:

(1) United States National Library of Medicine. 2011. Hazardous Substances Data Bank (HSDB) <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>(2) United States Environmental Protection Agency. 1999. *Partition Coefficients for Metals in Surface Water, Soil, and Waste*.(3) [http://www.chemicalbook.com/ChemicalProductProperty\\_EN\\_CB6133122.htm](http://www.chemicalbook.com/ChemicalProductProperty_EN_CB6133122.htm)



**FIGURE 7-1**  
AOC 6 TNT Subareas Conceptual Site Model  
AOC 6 TNT Subareas Remedial Investigation  
Cheatham Annex  
Williamsburg, Virginia

# Conclusions and Recommendations

This section summarizes the major conclusions of the RI for the AOC 6 TNT Subareas, which are based on the findings and results presented and evaluated in earlier sections of this report. It also presents a recommended path forward to address potentially unacceptable risks to human health or the environment from site-related COCs at the AOC 6 TNT Subareas.

The objectives of the RI have been achieved – data gaps have been filled, the nature and extent of contamination have been sufficiently defined, the CSM has been updated to reflect the compilation of data from all investigation activities to date, and human health and ecological risks have been assessed.

## 8.1 Conclusions

The HHRA and ERA presented herein identified the following COCs:

Risk Component	Medium		
	Surface Soil	Subsurface Soil	Groundwater
Human Health	TNT, 2-nitrotoluene, arsenic, hexavalent chromium, and lead*	TNT, 2-nitrotoluene, arsenic, and hexavalent chromium	Arsenic and iron
Ecological	TNT and lead	TNT and lead	No unacceptable risks to aquatic biota identified

\*Unlike the other listed COCs lead is not a COC when evaluating exposure to lead in soil across the full site; however, if only exposed to soil within the Catch Box Ruins, lead is a COC for Catch Box Ruins surface soil and combined surface and subsurface soil.

Although arsenic and iron were identified as groundwater COCs based on their conservative inclusion in the HHRA for evaluation, the concentrations of arsenic and iron found in groundwater during the RI at the AOC 6 TNT Subareas were attributable to naturally occurring background conditions and not the result of site-related contamination.

### 8.1.1 Soil

The human health COC 2-nitrotoluene was only detected in one of the thirty-nine soil samples; therefore, this concentration was used as the exposure point concentration, and the risks associated with exposure to 2-nitrotoluene across the site are likely over-estimated.

For the remaining COCs in soil, the concentrations of TNT, hexavalent chromium, arsenic, and lead exceeding screening criteria are shown on **Figure 8-1**.

No explosives were detected in groundwater during the SI; therefore, these contaminants are not leaching from the soil to groundwater.

### 8.1.2 Groundwater

Arsenic and iron were identified as COCs in groundwater in the HHRA. However, elevated arsenic and iron concentrations are attributed to naturally occurring background conditions reflective of the natural reductive dissolution process rather than the result of a CERCLA release. Monitoring wells located upgradient or sidegradient of the suspected release areas and in areas with soil concentrations below the background UTLs had arsenic and iron concentrations higher than monitoring wells downgradient of the release areas. Therefore, groundwater from these reference wells is considered to be representative of the range of background concentrations present in this area of CAX. Both arsenic and iron concentrations in

monitoring wells located adjacent to or downgradient of the suspected release areas were all below the ranges of representative background values.

With regard to ecological risk, groundwater would not pose an unacceptable risk to aquatic biota.

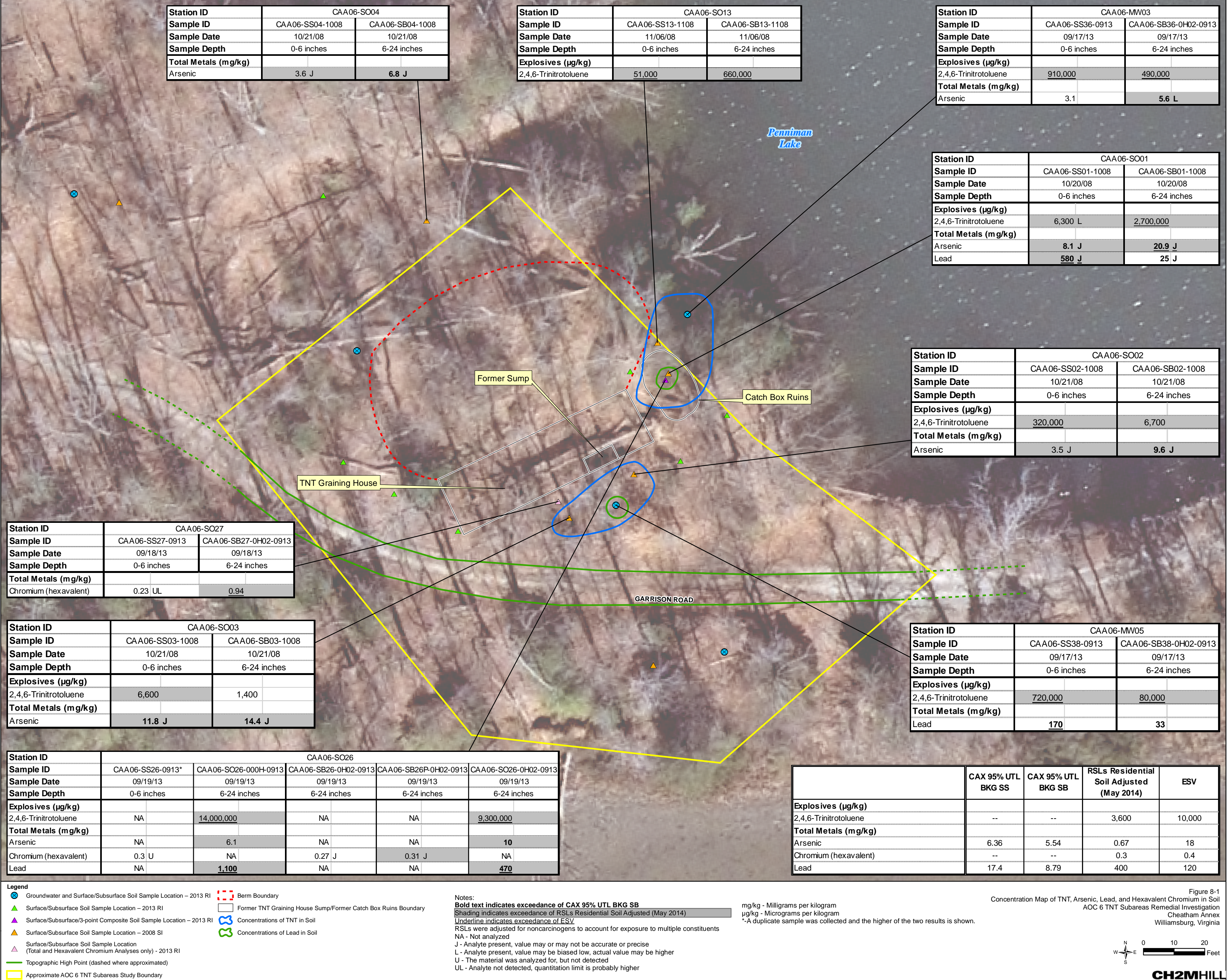
## 8.2 Recommendations

The following recommendations are proposed for the AOC 6 TNT Subareas:

1. Prepare an FFS to develop and evaluate remedial alternatives to address potentially unacceptable human health or ecological risks associated with TNT and lead in soil at the AOC 6 TNT Subareas. Since the size of the AOC 6 TNT Subareas is relatively small (approximately 0.5 acre) and the approximate boundaries of the TNT and lead contamination in soil are defined, an FFS would allow for a more efficient evaluation of several potential remedial alternatives.

No further action is recommended for arsenic and hexavalent chromium. The arsenic concentrations are within the range of soil background 95% UTLs (CH2M HILL, 2011), as shown on **Figure 8-1**. Hexavalent chromium was not detected in surface soil, and in subsurface soil, the risk to a residential receptor would fall within the acceptable risk range for this constituent, as discussed in Section 5.3.

2. Since there was only one detection of the human health COC 2-nitrotoluene, the risks associated with exposure to it across the site are likely over-estimated, and since this one detection is within the approximate distribution of TNT contamination south of the former TNT Graining House Sump, it would be addressed as part of the FFS remedial alternatives associated with TNT in this area, such that no further action with respect to 2-nitrotoluene is warranted.
3. No further action is recommended for groundwater since the groundwater data evaluated during this RI indicate that the concentrations of arsenic and iron in groundwater are likely attributable to naturally occurring background conditions and not from historical leakage or discharge from the former TNT Graining House Sump and/or TNT Catch Box Ruins.



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**Appendix A**  
**Soil Boring and Monitoring Well**  
**Construction Logs**

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PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW01**

SHEET 1 OF 1

## SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630268.9 N, 12035321.6 E)

ELEVATION : 13.8 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

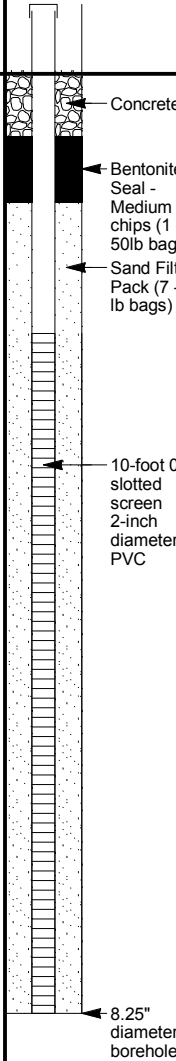
DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 7.7 ft bgs

START : 9/18/2013

END : 9/18/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION	SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
INTERVAL (ft)		RECOVERY (ft)	SAMPLE ID (TIME)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY				
13.8	0.0			<b>SILTY SAND (SM)</b> 0.0-2.8'- pale yellow, (5Y 8/2), dry, loose, fine to medium grained, nonplastic			Water level: 7.10 ft. msl (potentiometric - 10/02/2013)	
	4.0	4.0	S-1	2.8-5.8'- strong brown, (7.5YR 5-4/6), dry, dense to medium dense, fine to medium grained, low plasticity		0	Top of Well (PVC) Elevation: 16.75 ft msl	
5								
8.8								
	4.0	4.0	S-2	5.8-6.6'- Same as 2.8-5.8 except moist, medium to coarse grained, nonplastic		0	Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	
	8.0			<b>CLAY (CL)</b> 6.6-7.7'- dry, very stiff, medium plasticity, strong brown grading to light gray at 7.0ft bgs, trace silt				
				<b>SILT (ML)</b> 7.7-7.9'- yellowish red, (5YR 5/8), nonplastic, trace coarse sands, wet at 7.7ft bgs				
10								
3.8			S-3	<b>SILTY SAND (SM)</b> 7.9-11.2'- very dark grayish brown, wet, very loose, nonplastic, coarse sands with trace very fine pebble gravel, light greenish gray Silt lense at 9.0-9.1ft bgs		0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	
	12.0			<b>FAT CLAY (CH)</b> 11.2-15.2'- greenish gray, moist, very stiff, high plasticity, coarse brown sand lense at 12.4-12.6ft bgs, marbled dark reddish brown at 13ft bgs and 14.8ft bgs				
15			S-4			0		
-1.2								
	16.0			<b>CLAYEY SAND (SC)</b> 15.2-16.0'- pale brown, (2.5Y 8/2), wet, medium dense, very fine to fine grained, high plasticity, wet at 15.2ft bgs Bottom of Boring at 16.0 ft bgs on 9/18/2013				



PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW02**

SHEET 1 OF 1

## SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630217.5 N, 12035414.0 E)

ELEVATION : 15.4 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

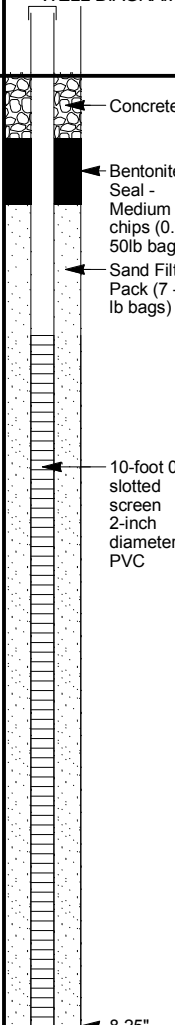
DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 6.9 ft bgs

START : 9/18/2013

END : 9/18/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION	SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
INTERVAL (ft)		RECOVERY (ft)	SAMPLE ID (TIME)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY				
15.4	0.0	4.0	S-1	<b>SILTY SAND (SM)</b> 0.0-0.5'- brown, (7.5YR 4/2), dry, very loose, fine grained, nonplastic, abundant roots/organic material 0.5-2.2'- pale yellow, (5Y 8/2), dry, dense, very fine to fine grained, nonplastic, trace black organics at top			Water level: 6.75 ft. msl (potentiometric - 10/02/2013)	
	4.0			<b>SILTY SAND-CLAYEY SAND (SC)</b> 2.2-6.9'- strong brown, (7.5YR 5-4/6), dry to moist, medium dense, fine to medium grained, low to medium plasticity		0	Top of Well (PVC) Elevation: 18.28 ft msl	
5 10.4		4.0	S-2				Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	
	8.0			<b>SILTY SAND (SM)</b> 6.9-9.0'- yellowish red, (5YR 5/8), wet, loose, nonplastic, wet at 6.9ft bgs, trace fine pebble gravel		0		10-foot 0.01 slotted screen 2-inch diameter PVC
10 5.4		4.0	S-3	<b>FAT CLAY (CH)</b> 9.0-10.4'- brownish yellow and light gray, (10YR 6/6 and 10YR 7/2), dry to moist, very stiff, high plasticity, trace silt and very fine grain sands		0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	
	12.0			<b>SILT (ML)</b> 10.4-10.6'- reddish brown, (2.5YR 4/4), moist to wet, nonplastic				
				<b>SILTY SAND (SM)</b> 10.6-13.9'- dark gray to very dark grayish brown, (2.5Y 4/1-3/2), wet, loose, coarse grained, nonplastic, wet at 10.6ft bgs, angular grains				
15 0.4		4.0	S-4	<b>FAT CLAY (CH)</b> 13.9-16.0'- moist, medium dense, nonplastic, greenish gray (5G 6/1) grading to light gray (2.5Y 7/2) at 15ft bgs, trace nodules and dark brown mottling		0		8.25" diameter borehole
	16.0			Bottom of Boring at 16.0 ft bgs on 9/18/2013				



PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW03**

SHEET 1 OF 1

## SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630229.4 N, 12035521.9 E)

ELEVATION : 11.9 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

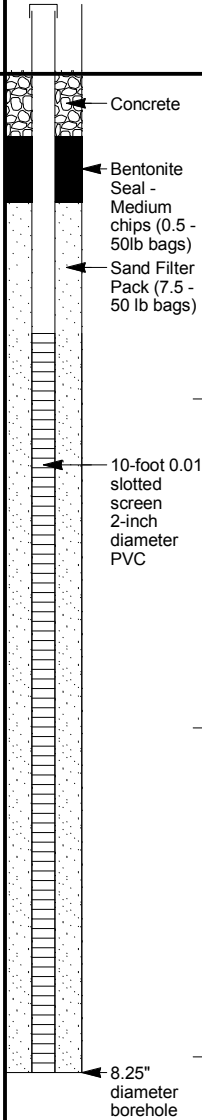
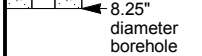
DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 4.5 ft bgs

START : 9/17/2013

END : 9/17/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION		SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
INTERVAL (ft)		RECOVERY (ft)	SAMPLE ID (TIME)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY					
11.9	0.0	4.0	S-1	<b>TOP SOIL (SM)</b> 0.0-0.3'- very dark gray, (10YR 3/1), dry, very loose, very fine to fine grained, nonplastic, abundant roots			0	Water level: 6.93 ft. msl (potentiometric - 10/02/2013)	
	4.0			<b>SILT (ML)</b> 0.3-0.7'- pale yellow, (5Y 8/2), dry, very loose, nonplastic, trace very fine grain sands, grades to below soil					
	4.0	4.0	S-2	<b>SILTY SAND (SM)</b> 0.7-4.5'- strong brown, (7.5YR 5/6), moist, dense, trace very fine grain sands, grades to below soil			0	Top of Well (PVC) Elevation: 14.86 ft msl	
5 6.9	4.0			4.5-6.5'- Same as 0.7-4.5 except wet, loose, coarse grained, higher silt content, wet at 4.5ft bgs					
	8.0	4.0	S-3	<b>CLAY WITH SAND (CL)</b> 6.5-6.8'- olive gray, (5Y 4/2), moist, soft, low plasticity			0	Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	
	8.0			<b>SILTY SAND (SM)</b> 6.8-8.7'- strong brown and greenish gray, wet, very loose to loose, coarse grained, low plasticity, high silt content					
10 1.9		4.0	S-4	<b>CLAY WITH SILT AND SAND (CL)</b> 8.7-9.3'- silt and coarse sand stringers			0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	
	12.0			<b>WELL GRADED SAND-SILTY SAND (SM)</b> 9.3-10.7'- wet, loose, coarse grained, nonplastic, dark greenish gray (10Y 4/1) from 9.3-9.7ft bgs, strong brown from 9.7-10.7ft bgs, very coarse sand and trace pebble gravel fractions					
	12.0	4.0	S-4	<b>CLAY WITH SILT AND SAND (CL)</b> 10.7-12.0'- wet, medium stiff to soft, low plasticity, laminated greenish gray (5G 6/1) and dark greenish gray (10Y 4/1), silt and coarse black sand stringers			0		
	12.0			<b>WELL GRADED SAND-SILTY SAND (SW)</b> 12.0-13.7'- dark greenish gray, (5G 6/1), wet, very loose to loose, nonplastic, very coarse sand fraction, sharp contact with soil below					
15 -3.1		4.0	S-4	<b>FAT CLAY (CH)</b> 13.7-16.0'- greenish gray, (5G 6/1), dry to moist, very stiff to hard, high plasticity, marbled dark greenish gray (10Y 4/1), up to 20% reddish brown nodules (14.6-16.0ft bgs), trace very fine grain to fine grain white inclusions			0		
	16.0			<b>Bottom of Boring at 16.0 ft bgs on 9/17/2013</b>					



PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW04**

SHEET 1 OF 1

# SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630119.2 N, 12035534.0 E)

ELEVATION : 12.9 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 7.5 ft bgs

START : 9/17/2013

END : 9/17/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION		SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM	
	INTERVAL (ft)		RECOVERY (ft)		SAMPLE ID (TIME)					
12.9	0.0	4.0	S-1	<b>SILTY SAND (SM)</b> 0.0-0.5'- brown, (7.5YR 4/2), dry, very loose, abundant roots/organic material	0	Water level: 4.73 ft. msl (potentiometric - 10/02/2013)	Concrete			
				<b>SILTY SAND (SM)</b> 0.5-1.2'- pale yellow, (5Y 8/2), dry, medium dense, very fine grained, nonplastic, high silt content						
	4.0			<b>SILTY SAND (SM)</b> 1.2-7.2'- strong brown, (7.5YR 4/6), dry to wet, dense, very fine to medium grained, nonplastic to low plasticity, wet at 7.2ft bgs containing loose coarse sand seam from 7.0-7.2ft bgs						
5		4.0	S-2	<b>CLAY WITH SILT AND SAND (CL)</b> 7.2-8.8'- strong brown, (7.5YR 5-4/6), wet, soft, low to medium plasticity, roots, organic material to 15%	0	Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	Grout Seal - Portland Type I/II			
7.9										
	8.0									
10		4.0	S-3	<b>SILTY SAND (SM)</b> 8.8-9.8'- very dark grayish brown, (2.5Y 3/2), wet, loose, medium to coarse grained, discolored very dark gray and strong brown	0					
2.9				<b>SILT (ML)</b> 9.8-10.4'- blue greenish gray, (10BG 4/1), moist, stiff, nonplastic, trace coarse very dark grayish brown sand seams						
	12.0			<b>SILTY SAND (SM)</b> 10.4-10.8'- Same as 8.8-9.8 except coarse grained						
		4.0	S-4	<b>SILT WITH CLAY (ML)</b> 10.8-12.0'- bluish green, (5B 5/1), moist, medium dense, nonplastic, laminated 10% very dark grayish brown, gradational between clay and silt	0					
15				<b>SILTY SAND-WELL GRADED SAND (SM)</b> 12.0-15.0'- strong brown and very dark gray, (2.5Y 4/1), wet, very loose, very coarse to coarse grained, nonplastic						
-2.1				<b>CLAY (CL)</b> 15.0-16.0'- greenish gray, (5G 6/1), dry to moist, very stiff, high plasticity						
	16.0	4.0	S-5	<b>SILTY SAND-WELL GRADED SAND (SM)</b> 16.0-16.9'- Same as 12.0-15.0	0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	10-foot 0.01 slotted screen 2-inch diameter PVC			
				<b>FAT CLAY (CH)</b> 16.9-20.0'- mottled light gray and reddish brown, (10YR 7/1 and 2.5YR 5/4), dry to moist, very stiff to hard, high plasticity, reddish brown nodules and brittle organic particles from 18.7-20.0ft bgs						
20	20.0			Bottom of Boring at 20.0 ft bgs on 9/17/2013			8.25" diameter borehole			



PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW05**

SHEET 1 OF 1

## SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630167.1 N, 12035498.5 E)

ELEVATION : 13.6 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

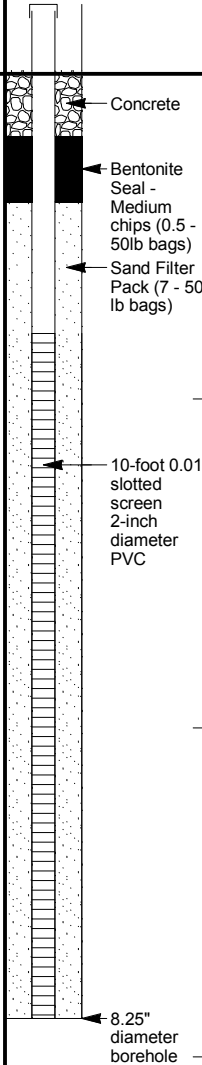
DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 7.3 ft bgs

START : 9/17/2013

END : 9/17/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION	SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
INTERVAL (ft)		RECOVERY (ft)	SAMPLE ID (TIME)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY				
13.6	0.0			<b>SILTY SAND (SM)</b> 0.0-0.8'- pale yellow, (5Y 8/2), dry, dense, nonplastic			Water level: 6.21 ft. msl (potentiometric - 10/02/2013)	
	4.0	4.0	S-1	<b>SILTY SAND/CLAYEY SAND (SM)</b> 0.8-9.3'- brown, (7.5YR 5-4/6), moist to wet, medium dense to dense, medium plasticity, medium grain 0.8-7.4ft bgs, medium coarse 7.4-9.3ft bgs, gradual change to lithology below		0	Top of Well (PVC) Elevation: 16.63 ft msl	
5								
8.6		4.0	S-2			0	Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	
	8.0							
10								
3.6		4.0	S-3	<b>CLAY WITH SAND (CL)</b> 9.3-10.6'- strong brown grading to light gray, sharp contact at base, (7.5YR 5/4 to 5Y 7/1), wet, soft to medium stiff, low plasticity		0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	
	12.0			<b>SILTY SAND (SM)</b> 10.6-13.5'- brown and greenish gray, (7.5YR 4/4 and Gley1 6/10GY), wet, dense, coarse to medium grained, low plasticity, brown 10.6-10.9ft bgs, greenish gray 10.9-13.5ft bgs, very fine grain silty sand, high silt content				
15		4.0	S-4	<b>FAT CLAY (CH)</b> 13.5-16.0'- greenish gray, (Gley1 5G 6/1)), dry to moist, very stiff to hard, high plasticity, trace silt, grades to light gray (2.5Y 7.2) at 15ft bgs, trace brown mottling with very fine to coarse nodules, trace very fine grain white particles		0		
-1.4								
	16.0			Bottom of Boring at 16.0 ft bgs on 9/17/2013				



PROJECT NUMBER:  
**387443.FI.FS**

BORING NUMBER:  
**CAA06-MW06**

SHEET 1 OF 1

## SOIL BORING LOG

PROJECT : AOC 6 TNT Subarea - Monitoring Well (MW) Installation

LOCATION : Cheatham Annex (CAX) Williamsburg, VA (3630225.3 N, 12035372.5 E)

ELEVATION : 14.9 ft NAVD88 (natural ground elevation)

DRILLING CONTRACTOR : Parratt-Wolff Drilling, Inc./J. Ellingworth

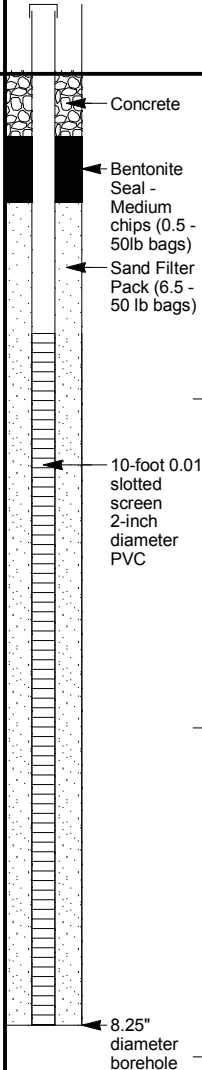
DRILLING METHOD AND EQUIPMENT : CME800 Track Mounted Rig, 4 1/4 ID 8 3/4 O.D. HSA, 4 ft Macro Core Sampler

WATER LEVELS : 7.0 ft bgs

START : 9/18/2013

END : 9/18/2013

LOGGER : T. Stewart/VBO

DEPTH BELOW EXISTING GRADE (ft)				SOIL DESCRIPTION		SYMBOLIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
INTERVAL (ft)		RECOVERY (ft)	SAMPLE ID (TIME)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY					
14.9	0.0	4.0	S-1	SILTY SAND (SM) 0.0-6.0'- strong brown and pale brown, (7.5YR 5/8 and 10YR 6/3), dry, medium dense, fine to medium grained, low plasticity, roots				Water level: 6.86 ft. msl (potentiometric - 10/02/2013)	
	4.0						0	Top of Well (PVC) Elevation: 17.81 ft msl	
5 9.9		4.0	S-2	6.0-9.5'- strong brown and light yellowish brown, (7.5YR 5/8 and 2.5Y 6/3), moist to wet, loose, coarse grained, nonplastic, moist then wet at 7ft bgs (perched zone), wet until 9.5ft bgs, yellowish red banding from 8.0-9.5ft bgs			0	Stick-up style surface completion, with a water-tight expansion cap and a lockable, protective steel cover	
	8.0								
10 4.9		4.0	S-3	CLAY WITH SILT (CL) 9.5-10.6'- greenish gray, (5G 5/1), moist, very stiff, high plasticity, high silt content from 9.5-9.7ft bgs, colored yellowish red 10.3-10.6ft bgs POORLY GRADED SAND-SILTY SAND (SM) 10.6-13.2'- dark gray to very dark grayish brown, (2.5Y 4/1-3/2), wet, loose to very loose, coarse grained, nonplastic, high silt content from 10.6-10.9ft bgs, sharp contact with lithology below			0	Elevations and coordinates (NAD83) as surveyed by ECLS, Inc. on September 23rd, 2013.	
	12.0								
15 -0.1		4.0	S-4	SILT (ML) 13.2-14.0'- very dark grayish brown and greenish gray, (2.5Y 3/2 and 5G 5/1), wet, nonplastic, 10% very fine grain sands FAT CLAY (CH) 14.0-16.0'- greenish gray, (5G 5/1), dry to moist, very stiff, high plasticity, high silt content from 14.0-14.2ft bgs, reddish brown nodules			0		
	16.0			Bottom of Boring at 16.0 ft bgs on 9/18/2013					

## Appendix B

### Survey Reports

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## CH2MHILL SURVEYOR REPORT

Surveying of Monitoring Well Locations at AOC 6 TNT Subareas

Remedial Investigation (RI) at Naval Weapons Station Yorktown; Cheatham Annex

Williamsburg, Virginia

Navy CLEAN 1000

CONTRACT N62470-08-D-1000

CTO-056

Page	1	Survey Control Stations
Page	2	Monitoring Wells/Soil Samples



10-21-13

Date of Survey: 09-23-2013

Name(s) of crew: Don Williams and Jose Ortiz

Temperature: 65°F; Barometric Pressure: 30.0

### Survey Control Stations:

The Horizontal values shown in this report are Virginia South State Plane Coordinate System of 1983 North Zone (NAD83). The Vertical values shown in this report are in NAVD 88 Datum current adjustment.

All coordinates shown in U.S. Survey Foot.

CONTROL SET	ELEV.	NORTHING	EASTING
CP 1: PKNAIL	10.66	3,630,269.76	12,035,942.31
CP 2: PKNAIL	10.76	3,630,200.45	12,035,788.21
CP 3: PKNAIL	11.32	3,630,137.30	12,035,528.45
CP 4: PKNAIL	12.85	3,630,140.88	12,035,439.47

Control Points 1 and 2 were established with Topcon Hyper Pro GPS receiver using 45 minute OPUS Static GPS sessions. OPUS Website then used to translate control points to Virginia South State Plane Coordinate System (NAD 83). Top Con 9003A Robotic total station was then used to locate each monitoring well and soil sample location. The following checks were made throughout the survey.

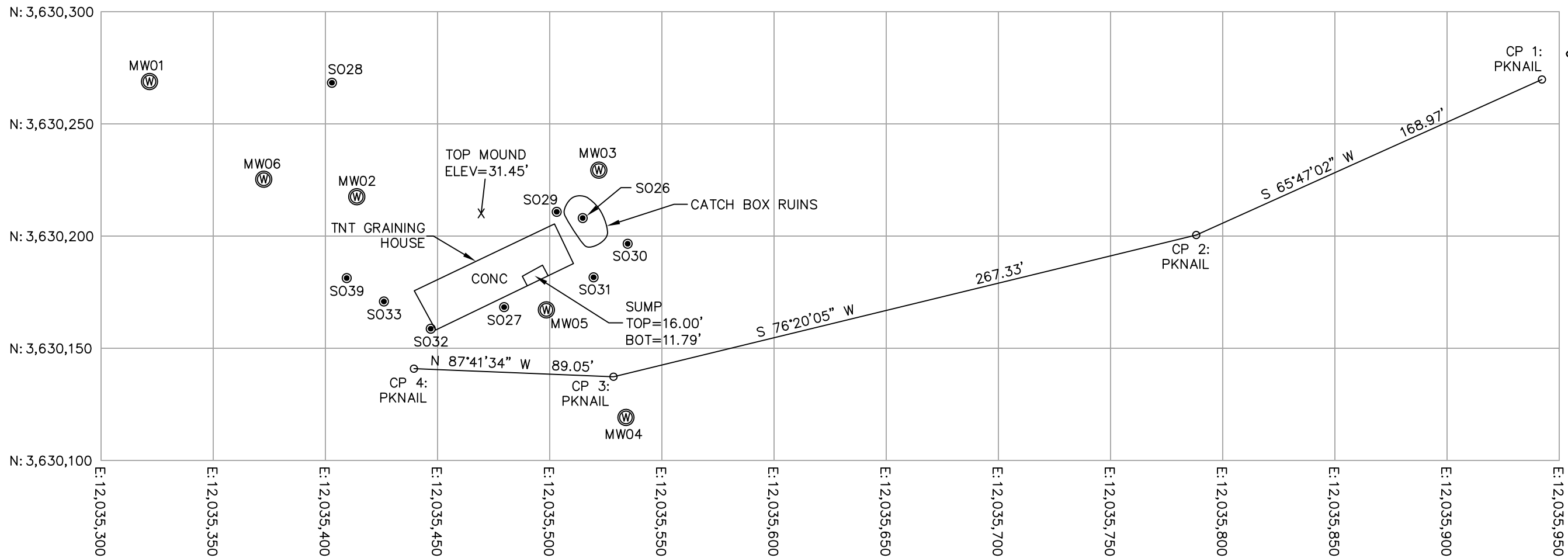
CONTROL CHECKS	ELEV.	NORTHING	EASTING
PT1 CHECK	10.66	3,630,269.76	12,035,942.31
PT2 CHECK	10.77	3,630,200.45	12,035,788.21
PT2 CHECK	10.75	3,630,200.45	12,035,788.20
PT3 CHECK	11.32	3,630,137.30	12,035,528.44
PT3 CHECK	11.31	3,630,137.30	12,035,528.45

**Monitoring Well Locations:**

WELL NUMBER	TOP OF WELL	TOP OF CASING	CONCRETE SURFACE	GROUND SURFACE	NORTHING	EASTING
	(ft msl)	(ft msl)	(ft msl)	(ft msl)		
CAA06-MW01	16.75	16.86	14.07	13.83	3,630,268.87	12,035,321.62
CAA06-MW02	18.28	18.51	15.70	15.37	3,630,217.52	12,035,414.01
CAA06-MW03	14.86	15.01	12.31	11.90	3,630,229.37	12,035,521.91
CAA06-MW04	15.86	16.09	13.20	12.91	3,630,119.16	12,035,533.99
CAA06-MW05	16.63	16.88	14.01	13.59	3,630,167.10	12,035,498.53
CAA06-MW06	17.81	17.95	15.22	14.88	3,630,225.33	12,035,372.54

**Soil Sample Locations:**

SOIL SAMPLE	ELEV.	NORTHING	EASTING
CAA06-SO26	8.85	3,630,208.02	12,035,514.72
CAA06-SO27	13.48	3,630,168.32	12,035,479.68
CAA06-SO28	10.99	3,630,268.31	12,035,402.95
CAA06-SO29	15.25	3,630,210.80	12,035,503.14
CAA06-SO30	13.21	3,630,196.55	12,035,534.76
CAA06-SO31	13.47	3,630,181.60	12,035,519.57
CAA06-SO32	14.36	3,630,158.69	12,035,446.98
CAA06-SO33	15.00	3,630,170.83	12,035,426.11
CAA06-SO39	15.57	3,630,181.26	12,035,409.52



WELL NUMBER	TOP OF WELL	TOP OF CASING	CONCRETE SURFACE	GROUND SURFACE	NORTHING	EASTING
	(ft msl)	(ft msl)	(ft msl)	(ft msl)		
CAA06-MW01	16.75	16.86	14.07	13.83	3,630,268.87	12,035,321.62
CAA06-MW02	18.28	18.51	15.70	15.37	3,630,217.52	12,035,414.01
CAA06-MW03	14.86	15.01	12.31	11.90	3,630,229.37	12,035,521.91
CAA06-MW04	15.86	16.09	13.20	12.91	3,630,119.16	12,035,533.99
CAA06-MW05	16.63	16.88	14.01	13.59	3,630,167.10	12,035,498.53
CAA06-MW06	17.81	17.95	15.22	14.88	3,630,225.33	12,035,372.54

SOIL SAMPLE	ELEV.	NORTHING	EASTING
CAA06-SO26	8.85	3,630,208.02	12,035,514.72
CAA06-SO27	13.48	3,630,168.32	12,035,479.68
CAA06-SO28	10.99	3,630,268.31	12,035,402.95
CAA06-SO29	15.25	3,630,210.80	12,035,503.14
CAA06-SO30	13.21	3,630,196.55	12,035,534.76
CAA06-SO31	13.47	3,630,181.60	12,035,519.57
CAA06-SO32	14.36	3,630,158.69	12,035,446.98
CAA06-SO33	15.00	3,630,170.83	12,035,426.11
CAA06-SO39	15.57	3,630,181.26	12,035,409.52

NOTE: FIELD DATA SURVEYED  
BY ECLS, INC. ON 09-23-2013

LEGEND

○ PK NAIL

⊙ MW = MONITORING WELL

● SO = SOIL SAMPLE

DATUM

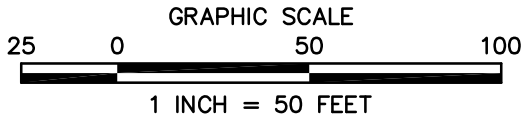
VA SOUTH GRID (NAD 83)  
VA SOUTH GRID (NAVD 88)

COMMONWEALTH OF VIRGINIA

G. DARRELL TAYLOR  
Lic. No. 2985

LAND SURVEYOR

*[Signature]*  
10-21-13



CONTROL SET	ELEV.	NORTHING	EASTING
CP 1: PKNAIL	10.66	3,630,269.76	12,035,942.31
CP 2: PKNAIL	10.76	3,630,200.45	12,035,788.21
CP 3: PKNAIL	11.32	3,630,137.30	12,035,528.45
CP 4: PKNAIL	12.85	3,630,140.88	12,035,439.47

SURVEYING OF MONITORING WELLS  
REMEDIAL INVESTIGATION AT NAVAL WEAPONS  
STATION YORKTOWN; CHEATHAM ANNEX  
WILLIAMSBURG, VIRGINIA  
NAVY CLEAN 1000 CONTRACT N62470-08-D-1000  
CTO-056

PROJ. NO.: CTO-056	FILENAME: AOC 6 TNT	DRAWN BY: DWS	SCALE: 1"=50'	DATE: 10-21-2013
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ECLS

ECLS

SURVEYING THE EAST COAST  
227 FISH DRIVE  
ANGIER, NC 27501  
910.897.3257  
910.897.2328 FAX

## CH2MHILL SURVEYOR REPORT

Surveying of Staff Gauge at Penniman Lake

Remedial Investigation (RI) at Naval Weapons Station Yorktown; Cheatham Annex

Williamsburg, Virginia

Navy CLEAN 8012

CONTRACT N62470-11-D-8012

CTO-WE47



9.8.14

Date of Survey: 08/22/2014

Name(s) of field survey members: Bryan Ross and Ross Nelson

Name(s) of office survey members: Darrell Taylor and Lori Swick

CH2M Hill Representative(s): Joe McCloud and Mark Ost

Temperature: 90°F; Barometric Pressure: 29.6

Sunny during a.m.; thunderstorms in p.m.

**Purpose:**

Determine the horizontal and vertical location of one staff gauge at Penniman Lake which is in the vicinity of the Cheatham Annex (CAX) AOC 6 TNT subareas, Williamsburg, Virginia.

**Survey Control Stations:**

The Horizontal values shown in this report are Virginia South State Plane Coordinate System of 1983 North Zone (NAD83). The Vertical values shown in this report are in NAVD 88 Datum current adjustment. Three monitoring wells were tagged to demonstrate consistent use of elevation control points. Said monitoring wells were previously located on September 23, 2013 by ECLS, Inc. (CTO-056). All coordinates are shown in U.S. Survey Foot.

Existing control from site well locations at AOC 6 TNT sub-areas which were previously established by ECLS, Inc. on September 23, 2013:

CONTROL	NORTHING	EASTING	ELEV.
CP 1: PKNAIL	3,630,269.76	12,035,942.31	10.66
CP 2: PKNAIL	3,630,200.45	12,035,788.21	10.76
CP 3: PKNAIL	3,630,137.30	12,035,528.45	11.32
CP 4: PKNAIL	3,630,140.88	12,035,439.47	12.85
MW 03	3,630,229.37	12,035,521.91	15.01
MW 04	3,630,119.16	12,035,533.99	16.09
MW 05	3,630,167.10	12,035,498.53	16.88

The following checks were made throughout the survey.

CONTROL CHECKS	NORTHING	EASTING	ELEV.
CP1 CHECK FROM CP2	3,630,269.75	12,035,942.30	10.66
DIFFERENCE	0.01	0.01	0.00
CP2 CHECK FROM CP 1	3,630,200.45	12,035,788.20	10.77
DIFFERENCE	0.00	0.01	-0.01
CP3 CHECK FROM CP 2	3,630,137.30	12,035,528.48	11.30
DIFFERENCE	0.00	-0.03	0.02
CP4 CHECK FROM CP3	3,630,140.89	12,035,439.41	12.86
DIFFERENCE	-0.01	0.06	-0.01
MW03 FROM CP3	3,630,229.37	12,035,521.78	15.00
DIFFERENCE	0.00	0.13	0.01
MW04 FROM CP3	3,630,119.16	12,035,533.96	16.10
DIFFERENCE	0.00	0.03	-0.01
MW05 FROM CP3	3,630,167.02	12,035,498.42	16.88
DIFFERENCE	0.08	0.12	0.00

The equipment used to conduct this survey was as follows:

Nikon NPR 332, data collector Nomad DCL I-C, Topcon Level ATG2

Horizontal control work complies with Third Order Class II (1:5,000) as outlined in the FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management. Vertical control work complies with Third Order (0.05v) as outlined in the FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management and Part 2: National Standard for Spatial Data Accuracy.

### Staff Gauge at Penniman Lake:

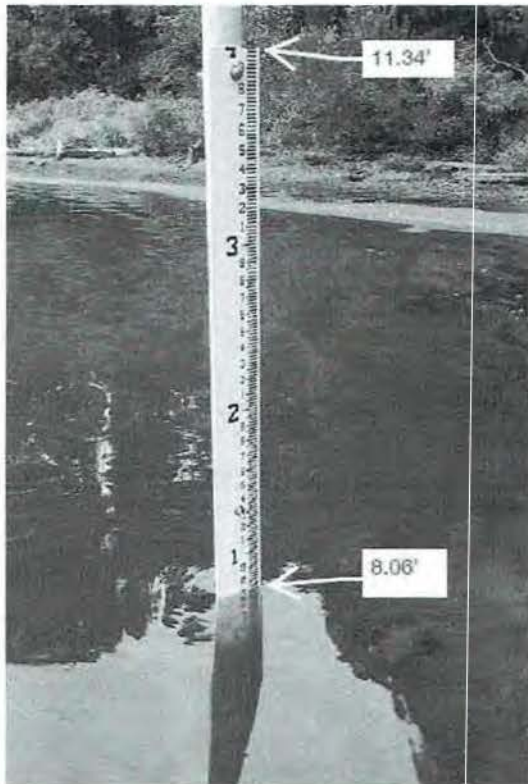
CH2M Hill personnel arbitrarily set the staff gauge at Penniman Lake at a random elevation. To obtain a NAV88 elevation, you would need to add 7.34' to the reading on the gauge. For example, the top of the staff gauge (the 4.0 reading) is actually 11.34' and the water level reading on the staff gauge at 2:00 pm on August 22, 2014 was 0.72' which equates to an elevation of 8.06'.

### Top of Staff Gauge

Virginia South State Plane Coordinate System of 1983 North Zone (NAD83) and NAVD 88 Datum

STAFF GAUGE	NORTHING	EASTING	ELEV.
TOP OF MOUNTING POLE	3,630,375.74	12,036,120.77	13.17
TOP OF GAUGE @ 4.0 MARK	3,630,375.74	12,036,120.77	11.34

Staff Gauge:



Steel Frame Weir close to staff gauge:



### **Survey Quality Control Plan:**

Throughout the course of this survey the following procedures were used:

All centering and height measurements were independently checked. Control stations were observed several times. Control station pairs were occupied using conventional equipment and distances measured as a check to GPS.

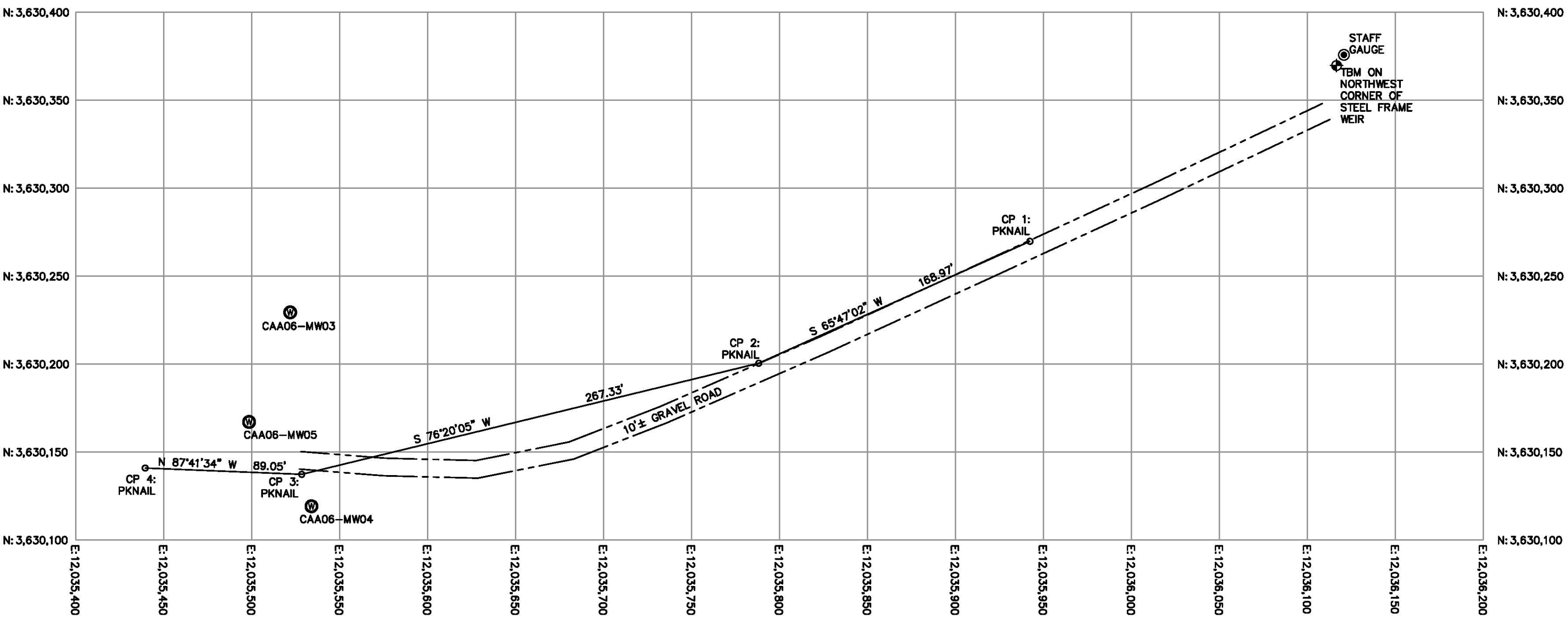
This report contains the following:

A scanned copy of field notes (PDF format).

A coordinate printout in Excel format containing the station ID and the horizontal and vertical coordinate information.

An Autocad electronic copy and hard copy of staff gauge location.

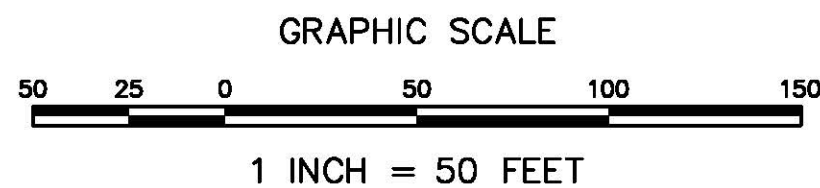
VA SOUTH GRID (NAD 83)			
VA SOUTH GRID (NAVD 88)			
	NORTHING	EASTING	ELEVATION
CP 1, PK NAIL	3,630,269.75	12,035,942.30	10.66
CP 2, PK NAIL	3,630,200.45	12,035,788.20	10.77
CP 3, PK NAIL	3,630,137.30	12,035,528.48	11.30
CP 4, PK NAIL	3,630,140.98	12,035,439.48	12.79
MONITORING WELL CAA06-MW03	3,630,229.37	12,035,521.78	15.00
MONITORING WELL CAA06-MW04	3,630,119.16	12,035,533.96	16.11
MONITORING WELL CAA06-MW05	3,630,167.02	12,035,498.42	16.88
TOP OF STAFF GAUGE	3,630,375.74	12,036,120.77	13.17
TBM MARK ON WEIR	3,630,369.70	12,036,116.60	11.72



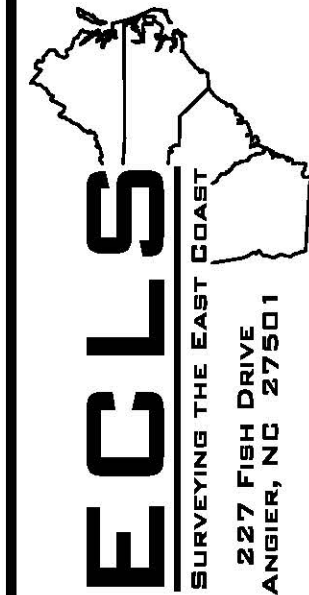
COMMONWEALTH OF VIRGINIA  
G. DARRELL TAYLOR  
Lic. No. 2985  
LAND SURVEYOR  
9-8-2014

NOTE: FIELD DATA SURVEYED  
BY ECLS, INC. ON 08-22-2014

LEGEND
○ PK NAIL
⊗ MW = MONITORING WELL
⊙ STAFF GAUGE
DATUM
VA SOUTH GRID (NAD 83)
VA SOUTH GRID (NAVD 88)



VA SOUTH GRID (NAD83)



REVISIONS:

SURVEY BY:

SURVEYING OF STAFF GAUGE AT PENNIMAN LAKE  
REMEDIAL INVESTIGATION AT NAVAL WEAPONS  
STATION YORFTOWN; CHEATHAM ANNEX  
WILLIAMSBURG, VA  
NAVY CLEAN 8012  
CONTRACT N62470-11-D-8012  
CTO-WE47

PROJ. NO.: CTO-WE47

FILENAME: 2014.CH2MHILL

DRAWN BY: LES

SCALE: 1" = 50'

DATE: 8/27/2014

ECLS

## Appendix C

### IDW Analytical Data

---

TABLE C-1

Investigation-Derived Waste Laboratory Analytical Results - October 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Sample ID	CAA06-IDW100313-AQ	CAA06-IDW100313-SO
Sample Date	10/3/13	10/3/13
<b>Chemical Name</b>		
<b>TCLP Volatile Organic Compounds (MG/L)</b>		
No Detections		
<b>TCLP Semivolatile Organic Compounds (MG/L)</b>		
No Detections		
<b>TCLP Pesticides/Polychlorinated Biphenyls (MG/L)</b>		
No Detections		
<b>TCLP Herbicides (MG/L)</b>		
No Detections		
<b>TCLP Metals (MG/L)</b>		
Barium	0.014 J	0.089 J
<b>Wet Chemistry (MG/KG)</b>		
Cyanide	0.081 J	0.05 U
<b>Reactivity (MG/KG)</b>		
No Detections		
<b>Corrosivity (PH)</b>		
pH	6.9	6.2
<b>Ignitability (DEG/F)</b>		
No Detections		

## Notes:

&gt; - Flashpoint is greater than the value reported, no flashpoint was observed

DEG/F - Degrees Fahrenheit

J - Analyte present. Value may or may not be accurate or precise

MG/KG - Milligrams per kilogram

MG/L - Milligrams per liter

NS - Not sampled

PH - pH units

U - The material was analyzed for, but not detected

Shading indicates detection

## Appendix D

### IDW Profiles and Disposal Manifests

---

## Material Characterization Form

### Applicant Information

Company Name: CH2M HILL, Inc.  
 Address: 5701 Cleveland Street, STE 200  
 City / State / Zip: Virginia Beach, VA 23462  
 Contact: Laura Lampshire  
 Phone: 301.570.1042  
 Fax:  
 e-mail: Laura.Lampshire@CH2M.com

### Generator Information

Company Name: NAVFAC Mid-Atlantic  
 Address: 9742 Maryland Ave. Bldg. N-26  
 City / State / Zip: Norfolk, VA 23511  
 Contact: Scott Park  
 Phone: 757-341-0481  
 Fax: 757-341-0399  
 e-mail: scott.park@navy.mil

### Project Description

Site Name: AOC 8 & AOC 6 TNT Subareas  
 Site Address: Naval Weapons Station Yorktown, Cheatham Annex (CAX), Williamsburg, VA  
 Source of Contamination: AOC 8 source – buried debris; AOC 6 – historical potential discharges related to the TNT Graining process  
 Waste Generating Activity: Monitoring Well Installation, Development, and Purging Activities and Decontamination Activities

### Waste Description

Applicant must complete the following information and attach all laboratory analyses and / or MSDS utilized to characterize the material as non-hazardous and acceptable for receipt by Clearfield MMG.

**General Description:** Non-Hazardous Soil  
**Matrix:** ☒ Soil ☐ Sludge ☐ Water ☐ Debris / Absorbents  
**Petroleum Type:** ☐ Virgin (un-used) ☐ Non-Virgin (used) ☒ None  
 (Check all that apply) ☐ Gas ☐ Diesel / # 2 ☐ Motor / Hydraulic Oil ☐ # 4, 5, or 6 Oil  
**Other Contaminants:** See Analysis  
**Volume:** 23 Drums **Lab Analysis Completed:** ☒ YES ☐ NO

### Generator Certification

I hereby certify, based upon my diligent inquiry into the activities and processes generating the waste described on this form, that these materials are not classified as listed or characteristic hazardous waste as regulated by the Commonwealth of Virginia or the state of origin of this waste; that the materials do not contain 50.0 parts per million or more of polychlorinated biphenyls (PCB's); that the analytical results, completed *Material Characterization Form* and attached documentation are a representative, true, and accurate description of these materials; that no deliberate or willful omissions have been made in the preparation of this form; and that all known or suspect hazards have been disclosed herein. I further acknowledge that I am aware it is the duty of all persons to dispose of their solid waste in a legal manner (Va.Code ' 10.1-1418.1.A).

PARK.SCOTT.R.1229816159

 Digitally signed by PARK.SCOTT.R.1229816159  
 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN,  
 cn=PARK.SCOTT.R.1229816159  
 Date: 2013.11.07 13:58:14 -0500
 

Scott R. Park

Generator or Agent Signature / Date

Generator or Agent Printed Name

If I am an agent signing on behalf of the generator, I have confirmed with the generator that the information contained in this profile is accurate and complete.

### For Facility Use Only

Approved By: \_\_\_\_\_  
 Approval Date: \_\_\_\_\_

Approval Code: \_\_\_\_\_  
 Comments: \_\_\_\_\_

**All Deliveries Must be Accompanied by an Approved MCF or Reference Approval Code on Manifest**

## Material Characterization Form

### Applicant Information

Company Name: CH2M HILL, Inc.  
 Address: 5701 Cleveland Street, STE 200  
 City / State / Zip: Virginia Beach, VA 23462  
 Contact: Laura Lampshire  
 Phone: 301.570.1042  
 Fax:  
 e-mail: Laura.Lampshire@CH2M.com

### Generator Information

Company Name: NAVFAC Mid-Atlantic  
 Address: 9742 Maryland Ave. Bldg. N-26  
 City / State / Zip: Norfolk, VA 23511  
 Contact: Scott Park  
 Phone: 757-341-0481  
 Fax: 757-341-0399  
 e-mail: scott.park@navy.mil

### Project Description

Site Name: AOC 8 & AOC 6 TNT Subareas  
 Site Address: Naval Weapons Station Yorktown, Cheatham Annex (CAX), Williamsburg, VA  
 Source of Contamination: AOC 8 source – buried debris; AOC 6 – historical potential discharges related to the TNT Graining process  
 Waste Generating Activity: Monitoring Well Installation, Development, and Purging Activities and Decontamination Activities

### Waste Description

Applicant must complete the following information and attach all laboratory analyses and / or MSDS utilized to characterize the material as non-hazardous and acceptable for receipt by Clearfield MMG.

**General Description:** Non-Hazardous Liquid  
**Matrix:** ☐ Soil ☐ Sludge ☒ Water ☐ Debris / Absorbents  
**Petroleum Type:** ☐ Virgin (un-used) ☐ Non-Virgin (used) ☒ None  
 (Check all that apply) ☐ Gas ☐ Diesel / # 2 ☐ Motor / Hydraulic Oil ☐ # 4, 5, or 6 Oil  
**Other Contaminants:** See Analysis  
**Volume:** 27 Drums **Lab Analysis Completed:** ☒ YES ☐ NO

### Generator Certification

I hereby certify, based upon my diligent inquiry into the activities and processes generating the waste described on this form, that these materials are not classified as listed or characteristic hazardous waste as regulated by the Commonwealth of Virginia or the state of origin of this waste; that the materials do not contain 50.0 parts per million or more of polychlorinated biphenyls (PCB's); that the analytical results, completed *Material Characterization Form* and attached documentation are a representative, true, and accurate description of these materials; that no deliberate or willful omissions have been made in the preparation of this form; and that all known or suspect hazards have been disclosed herein. I further acknowledge that I am aware it is the duty of all persons to dispose of their solid waste in a legal manner (Va.Code ' 10.1-1418.1.A).

PARK.SCOTT.R.1229816159

Digitally signed by PARK.SCOTT.R.1229816159  
 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN,  
 cn=PARK.SCOTT.R.1229816159  
 Date: 2013.11.07 13:55:06 -0500

Scott R. Park

Generator or Agent Signature / Date

Generator or Agent Printed Name

If I am an agent signing on behalf of the generator, I have confirmed with the generator that the information contained in this profile is accurate and complete.

### For Facility Use Only

Approved By: \_\_\_\_\_  
 Approval Date: \_\_\_\_\_

Approval Code: \_\_\_\_\_  
 Comments: \_\_\_\_\_

**All Deliveries Must be Accompanied by an Approved MCF or Reference Approval Code on Manifest**

## Appendix E

### Data Quality Evaluation

---

# Data Quality Report for Cheatham Annex Area of Concern 6, TNT Subareas, Williamsburg, Virginia

---

## E.1 Data Quality Evaluation Process

This data quality evaluation assesses the effect of the overall analytical process on the availability of the analytical data. “Availability” in this context refers to whether results can be used by the project team, and is based on the analytical soundness of the results, as determined in the evaluation process. If a result is analytically sound, it is available for use in evaluating the potential release, nature, and extent of contamination, and estimating potentially associated human health and ecological risks. Though results are available, the data user may consider a particular result or group of results to be not usable for one or more purposes if other conditions apply. In order to avoid confusion of terms, this data quality evaluation differentiates the “availability” of results from “usability” of results.

Three major categories of data evaluation are considered: laboratory performance, field collection performance, and matrix interference. Evaluation of laboratory performance is a check of the laboratory’s compliance with the method and client-specified requirements. Evaluation of field collection performance is a review of field quality control (QC) samples such as equipment blanks and field duplicates. Evaluation of potential matrix interference involves the review of supporting data such as surrogate recoveries and matrix spike (MS) recoveries.

Data evaluation is a multi-tiered approach, as outlined in Worksheet 34-36 of the Cheatham Annex *Tier II Sampling and Analysis Plan for AOC6 TNT Graining House Sump and TNT Catch Box Ruins Subareas – Remedial Investigation* (CH2M HILL, 2013). The process begins with an internal review by the laboratory, continues with validation, and ends with an overall review by the CH2M HILL project chemistry team and the production of this report. While only the data validator applies final qualifiers to the data, the tiered-approach allows for data quality to be evaluated thoroughly and provides a medium for essential communication among the laboratory, validator, and project team.

### E.1.1 Laboratory Internal Quality Control Review

During analysis and prior to releasing the analytical data, the laboratory reviewed both the client sample and laboratory QC sample data to verify sample identity, instrument calibration, quantitation limits, dilution factors, numerical computations, transcription accuracy, and chemical identification. The QC data were tabulated and the results reviewed to determine whether they were within the limits for accuracy and precision. Corrective action was taken and any non-conforming data was discussed in the data package cover letter and case narrative.

To identify the need for corrective action, the laboratory referred to their in-house Standard Operating Procedures (SOPs) and the specifications of the Sampling and Analysis Plan(s) (SAPs) specific to this project. Laboratory SOPs were based on the analytical method, Department of Defense requirements, and accumulated laboratory experience; the SAPs were Cheatham Annex *Tier II Sampling and Analysis Plan for AOC6 TNT Graining House Sump and TNT Catch Box Ruins Subareas – Remedial Investigation* (CH2M HILL, 2013).

### E.1.2 Data Validation

Validation was performed by CH2M HILL. The validator reviewed all definitive data packages, qualified data, and reduced the dataset to present only one result per analyte, per sample. For each sample, and each analyte, the validator retained the result with the highest data quality and excluded any other results (from re-extraction, re-analysis, or multiple dilutions) to avoid redundancy.

During this review and determination of the need for qualification, the validator evaluated analytical results against the quality assurance (QA)/QC criteria of the SAP, analytical methods, and laboratory SOPs, respectively. The data qualifiers applied are those presented in *Region III Modifications to the National Functional Guidelines for Organic Data Review* (USEPA, 1994) and *Region III Modifications to National Functional Guidelines for*

*Inorganic Data Review* (USEPA, 1993). National Functional Guidelines may have also been used during validation if criteria did not contradict criteria in the SAPs.

The data validation was focused on the laboratory's performance and the sample matrix and their effects on the analytical results. Areas of review consisted of holding time compliance, surrogate recovery accuracy, blank contamination (trip, equipment, and method blanks), initial and continuing calibration accuracy and precision, laboratory control sample (LCS) accuracy, internal standard response and retention time accuracy, instrument tune criteria accuracy, matrix spike and matrix spike duplicate (MS/MSD) recovery and duplicate sample precision (laboratory and field duplicates). Additionally, the analytical spectrum and raw data output were reviewed and 10% of the laboratory results were recalculated from the raw data to verify final laboratory identification and quantitation.

### **E.1.3 Precision, Accuracy, Representativeness, Completeness, Comparability (PARCC)**

Throughout the data evaluation process, data quality is evaluated by the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data. For reference, PARCC is defined as:

#### **E.1.3.1 Precision**

Precision is defined as the agreement between duplicate results, and was characterized by comparing the relative percent differences (RPDs) of MS/MSD, laboratory control sample (LCS) and its duplicate, serial dilutions, laboratory replicates, and/or field duplicate sample results. For this data set, precision was also assessed by examining dual-column reproducibility (percent difference between instrument columns) for explosives. Although results may have been qualified due to QC exceedances that may suggest an impact on precision, there is no actual significant negative impact on precision unless a data point is deemed unavailable (rejected) due to precision exceedances.

#### **E.1.3.2 Accuracy/Bias**

Accuracy/bias is a measure of the agreement between an analytical determination and the true value of the parameter being measured. For organic analyses, each sample was spiked with surrogate compounds; and for both organic and inorganic analyses, an MS/MSD and LCS were spiked with a known analyte concentration before preparation. Internal standards, surrogates and MS/MSDs provide a measure of the matrix effects on the analytical accuracy. The LCS demonstrates accuracy of the method and the laboratory's ability to meet the method criteria. Accuracy/bias is also assessed by calibration recoveries. Although results may have been qualified due to QC exceedances which may suggest an impact on accuracy/bias, there is no actual significant negative impact on accuracy unless a data point is deemed unusable (rejected) due to accuracy exceedances.

#### **E.1.3.3 Representativeness**

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition (in this case, the nature and extent of contamination). Representativeness is a subjective parameter and is used to evaluate the efficacy of the sample planning design. In terms of data quality, representativeness is assured by the sampling team by following approved standard operating procedures (SOPs) for sample collection and handling, and the laboratory following approved SOPs for sample handling, preparation, and analysis.

#### **E.1.3.4 Completeness**

Completeness is calculated as the number of analytically-sound results that are available for use compared to the total number of measurements made. All results except those R-qualified as "rejected" are available for use as analytically-sound results. The R-qualifier is the only qualifier that negatively affects a data point's availability. The completeness of the dataset will be compared to a completeness goal identified in the UFP-SAP, or a goal of 95% if no goal was identified in the SAP.

#### **E.1.3.5 Comparability**

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Factors that affect comparability are sample collection and handling techniques, sample

matrix, and analytical methods. If SOPs are followed, then with the exception of data that has been rejected due to quality exceedances, precision and accuracy are said to be acceptable and the data user may be confident that this data set is comparable to others of high data quality.

## E.2 Qualifiers and Reasons

### E.2.1 Availability of Qualified Data

The qualifiers applied during validation affect the availability of the results and may affect their usability for certain purposes. The qualifiers in **Table 2-1** were applied to the dataset during the data quality evaluation process. For definitive data (organics and inorganics), final qualifiers are issued by the validator; for screening data, the laboratory qualifiers are considered final qualifiers. Qualifiers are discussed in greater detail in **Sections 2.1.1 through 2.1.5**, and reasons for applying these qualifiers are discussed in **Section 2.2**.

TABLE 2-1  
Final Qualifiers Applied

Qualifier	Meaning	Percent of Data Qualified	Count
[NONE]	Detected	55.07%	993
U	Nondetect at the reported concentration	31.56%	569
J	Detected concentration estimated	6.66%	120
B	Attributed to blank contamination	6.10%	110
L	Detected, concentration biased low	0.22%	4
K	Detected, concentration biased high	0.22%	4
UL	Nondetect, quantitation limit biased low	0.11%	2
R	Rejected, data not available due to gross QA/QC issues	0.06%	1
<b>Totals:</b>		<b>100.00%</b>	<b>1,803</b>

#### E.2.1.1 R-Qualified Results

In certain cases, a result is rejected and deemed to be unavailable. “Unavailable” in this instance is defined as a result that is not analytically sound and is not considered available for use by the project team. The R-qualifier is the only qualifier that may have an adverse effect on the availability of data. There is one rejected data point in this data set.

#### E.2.1.2 Results with No Qualification

The absence of a qualifier indicates that the analyte was detected at the reported concentration and no qualification was warranted.

#### E.2.1.3 J-, UJ-, and U-Qualified Results

The J-qualification, UJ-qualification, and U-qualification of results are common occurrences and have no adverse effect on the availability of that result to the project team for making decisions. J-qualified results are available for use as detects at the reported result as long as they are considered “estimated” by the project team. Human health risk assessment guidance suggests that these qualifiers “indicate uncertainty in the reported concentration of the chemical, but not in its assigned identity. Therefore, these data can be used just as positive data with no qualifiers or codes.” In addition, one is to use “J-qualified concentrations the same way as positive data that do not have this qualifier” (USEPA, 1989). U-qualified and UJ-qualified results are available for use as nondetects at the reported quantitation limit as long as they are considered “nondetect,” or “nondetect, estimated quantitation limit,” as appropriate.

#### E.2.1.4 B-Qualified Results

The B-qualification indicates that the results may be attributable to field or laboratory blank contamination, and that the analyte was detected in an associated blank as well as in the sample. If the B-qualifier is applied to definitive data, the results are usable as nondetects as long as they are considered “not detected at significantly greater concentration than that in an associated blank.” If the B-qualifier is applied to screening data, the results are usable as detects as qualified.

#### E.2.1.5 K-, L-, and UL-Qualified Results

The K-qualification, L-qualification, and UL-qualification indicate the data is affected by an undeterminable degree of positive or negative bias. This may indicate the presence of a QC problem, but not a problem severe enough to warrant rejection of data. K-qualified results are usable as detects as long as they are considered “estimated and biased high.” L-qualified results are available for use as detects and UL-qualified results are usable as nondetects as long as L- and UL-qualified results are considered “estimated and biased low.”

### E.2.2 Reasons for Data Qualification

When qualifying data the validator associates a reason code to explain why the qualification was made. Examining reasons for qualifying data provides insight into whether QC issues were encountered due to laboratory performance, field collection performance, or matrix interference. **Table 2-2** provides a list of the combinations of qualifiers and reason codes applied to this dataset, their definitions, and identifies the impact of these qualifications on data quality. Whenever data is available for use as reported or as qualified, there is no impact on the availability of data for use by the project team.

TABLE 2-2  
Reasons for Data Qualification

Qualifier	Reason Code	Count	Percent	Explanation	Impact on PARCC
<b><i>Data Available as Reported</i></b>					
[NONE]	[NONE]	993	55.07%	Constituent was detected and further qualification was not necessary as there were no QA/QC exceedances. The result is available as a detect as reported.	none
U	[NONE]	569	31.56%	Constituent was analyzed for but not detected. Further qualification was not necessary as there were no QA/QC exceedances. The result is available as a nondetect at the reported quantitation limit.	none
J	[NONE]	105	5.82%	Constituent was detected at a concentration less than the quantitation limit and was thus qualified as estimated by the laboratory. Further qualification was not necessary as there were no QA/QC exceedances. The result is available as a detect as reported.	none
<b><i>Data Available as Qualified</i></b>					
J	OT	11	0.61%	Constituent was detected. Result is J-qualified for a reason specified in the DV report. In most instances the data was qualified due to dissolved metals results being greater than total metals results. The QA/QC exceedance (potential precision issue) was not severe enough to warrant rejection. In other instances, the data was qualified due to poor recoveries of the LOQ verification standard. The result is available as a detect as qualified.	none
J	FD	4	0.22%	Constituent was detected. Result is J-qualified due to poor reproducibility between the parent and field duplicate. The QA/QC exceedance (potential precision issue) was not severe enough to warrant rejection. The result is available as a detect as qualified, the greater of the parent and duplicate results should be used.	none
B	MBL	11	0.61%	Constituent was detected. The result is B-qualified due to method blank contamination. The result is available as a nondetect as qualified.	none
B	EBL	80	4.44%	Constituent was detected. The result was B-qualified due to equipment blank contamination. The result is available as a nondetect as qualified.	none
B	CCBL	19	1.05%	Constituent was detected. The result was B-qualified due to continuing calibration blank contamination. The result is available as a nondetect as qualified.	none
K	MSH	4	0.22%	Constituent was detected. The result was K-qualified due to high recovery in the matrix spike and/or matrix spike duplicate. The QA/QC exceedance (potential high bias) was not severe enough to warrant rejection. The result is available as a detect as qualified.	none
L	MSL	4	0.22%	Constituent was detected. The result was L-qualified due to low recovery in a matrix spike and/or matrix spike duplicate. The QA/QC exceedance (potential low bias) was not severe enough to warrant rejection. The result is available as a detect as qualified.	none

TABLE 2-2  
Reasons for Data Qualification

Qualifier	Reason Code	Count	Percent	Explanation	Impact on PARCC
UL	MSL	2	0.11%	Constituent was analyzed for but not detected. The result was UL-qualified due to low recovery in the matrix spike and/or matrix spike duplicate. The QA/QC exceedance (potential low bias) was not severe enough to warrant rejection. The result is available as a nondetect as qualified.	none
<b>Data Not Available</b>					
R	MSL	1	0.06%	Constituent may or may not have been detected. The result was R-qualified due to severely low recovery in the MS or MSD, such that there is little confidence the constituent would be detected at an accurate concentration. This is indicative of matrix effects or matrix interference and laboratory performance is often assured by acceptable laboratory control sample recoveries. The QA/QC exceedance (extreme low bias) was severe enough that the result should not be used as a detect or as a nondetect for any purpose. This has a negative impact on completeness and a negative impact on accuracy. Because the direction of bias is known, the data user may choose to use these data points (as conservative exceedances understanding that the result may be higher than reported) if the result was detected and exceeded a project action limit. Rejected data is also discussed in Section 4 (specifically 4.1.3 Organics).	Completeness, Accuracy
Totals:		1803	100.00%		

99.94% not R-flagged and available for use

## E.3 Evaluation of Data against Project Action Limits

When nondetect results are reported at a value greater than project action limits (PALs), the results are available for use as nondetects, but their use may add uncertainty to the conclusions drawn. This is a relatively common occurrence, and there are a variety of potentially unavoidable reasons why the value at which nondetects are reported nondetect may exceed PALs, but the following two are the most common:

- Current technology may not be able to achieve an LOD or DL less than the PAL, in such cases the PAL is considered unreasonably low
- Soil samples may be too wet to achieve the PAL; samples are reported on a dry-weight basis, so if a soil sample is characterized by high percent moisture, then the reporting limits will be elevated

When drafting the UFP-SAP for Cheatham Annex Area of Concern 6, it was anticipated that some PALs would not be met. This is detailed in Tables A1-1 through A1-10 of the UFP-SAP with shading of the PALs that would not be met (CH2M HILL, 2013).

As part of the data quality evaluation, nondetected results, their associated nondetect value (the LOD), and the detection limit (DL) are compared to the minimum PAL (or to the background value if one exists). Such a comparison identifies instances where there is uncertainty regarding whether the analyte is present above the PAL (or background) due to the detection limits of the method and instrument. Since any concentration greater than the DL would be reported as a detection, uncertainty only exists when the DL is greater than the PAL. The different permutations for the PAL, LOD, and DL are summarized in **Table 3-1**, along with their impact on certainty of absence.

TABLE 3-1  
Possible Arrangements for PAL, LOD, and DL, and Impact on Certainty of Absence

PAL relative to limits	Impact on Certainty of Absence
<u>PAL</u> > LOD > DL	barring other qualifications, there is certainty that the analyte is not present above the PAL, this is apparent on data tables
LOD > <u>PAL</u> > DL	barring other qualifications, there is certainty that the analyte is not present above the PAL, however this may not be apparent from data tables
LOD > DL > <u>PAL</u>	though the data is qualified as nondetect, there is uncertainty regarding whether the analyte is present at a concentration exceeding the PAL; this may not be apparent from data tables
PAL (project action limit) – the comparison criteria	
LOD (limit of detection) – the value at which nondetects are reported in data tables	
DL (detection limit) – the lowest concentration the instrument can detect; any response greater than this is reported as a detection	

Lists of all data for which the PAL is lower than the LOD or the DL is included in **Table 3-2**. Data for which PAL is lower than the DL is discussed in Section 4 for each media and analytical group as appropriate.

### Comparison Criteria

The comparison criteria considered in **Table 3-2** were as follows; note that in cases where a background value exists, the results and their DLs are compared to the background value instead of the minimum PAL.

- Groundwater: Federal Maximum Contaminant Levels (MCLs) and Adjusted USEPA Regional Screening Levels (RSLs) for Tapwater from May 2014
- Surface and Subsurface Soil: Adjusted USEPA RSLs for Residential Soil from May 2014, Ecological Screening Values and Cheatham Annex background values for surface soil or subsurface soil (as appropriate)

## E.4 Data Quality Evaluation

In this section data qualifiers and the reason for their use are presented by site, media, and analytical grouping. Qualifiers and the reason codes are defined in **Section 2**.

Each subsection by media and analytical grouping includes a summary table of qualifications. The table shows the qualifiers and the reason for their use in order of decreasing frequency, and each qualifier is identified as being either available as reported by the laboratory, available as qualified by the validator, or not available. The impact on Precision, Accuracy, Representativeness, Completeness and Comparability (PARCC) is identified. Statistics are also included: a count and percentage of the number of instances of each type of qualification is shown. Note that the statistics in these tables consider only parent and field duplicate results; data for quality control samples such as MS/MSD and blanks are not counted. The last row of the table shows the statistics totals.

A discussion is included if data that was deemed unusable or if there are other quality issues that should be considered during data use. In many cases the data is 100% usable and the need for qualification was sporadic and unremarkable; therefore the table is presented with no discussion, which implies that the data is of excellent quality.

### E.4.1 AOC6 TNT Subareas

Samples were collected from Cheatham Annex Area of Concern 6 in the months of September and October 2013. Analysis was performed by Trimatrix Laboratories, with select analyses by ALS Environmental-Rochester (formerly Columbia Analytical Services-Rochester).

#### E.4.1.1 Groundwater

##### Inorganics Data

Total and dissolved metals, including mercury and cyanide, were analyzed by the methods specified in the AOC 6 SAP (SW-846 6010C, 6020A, 7470A and 9014, respectively). The validation process issued the qualifiers shown in the following table.

Qualifier	Reason Code	Count	Percent	Available as Reported	Available as Qualified	Impact on PARCC
U	[NONE]	124	37.69%	X		none
[NONE]	[NONE]	119	36.17%	X		none
B	EBL	40	12.16%		X	none
J	[NONE]	15	4.56%	X		none
B	CCBL	14	4.26%		X	none
J	OT	11	3.34%		X	none
B	MBL	6	1.82%		X	none
		329	100.00%	78.42%	21.58%	

100.00% not R-flagged and available for use

All data is of sufficient quality to evaluate whether action limits were met, with the exception of data for which the DL was greater than the comparison criteria. Affected nondetect data are listed in **Table 3-2**, and include data for total cyanide and total and dissolved chromium and thallium in many samples. These results are available for use as nondetects, but their use may add uncertainty to the conclusions drawn.

##### Screening Data

Natural attenuation indicator parameters (NAIPs) (alkalinity, chloride, sulfate, sulfide, nitrite, nitrate, methane, pH, and TOC) were analyzed by the methods specified in the AOC 6 SAP (CH2M HILL, 2013). The data review process issued the qualifiers shown in the following table. The NAIP data is 100% complete and available for use as screening data.

Qualifier	Reason Code	Count	Percent	Available as Reported	Impact on PARCC
[NONE]	[NONE]	54	100%	X	none
		54	100.00%	100.00%	

100.00% not R-flagged and available for use

#### E.4.1.2 Surface Soil

##### Organics Data

Explosives were analyzed by the methods specified in the AOC 6 SAP (SW-846 8330B). The validation process issued the qualifiers shown in the following table.

Qualifier	Reason Code	Count	Percent	Available as Reported	Available as Qualified	Impact on PARCC
U	[NONE]	218	91.60%	X		none
[NONE]	[NONE]	16	6.72%	X		none
J	[NONE]	4	1.68%	X		none
		238	100.00%	100%		

100.00% not R-flagged and available for use

##### Inorganics Data

Metals, including mercury, cyanide and hexavalent chromium, were analyzed by the methods specified in the AOC 6 SAP (SW-846 6010C, 6020A, 7471B, 9014 and 7199, respectively). The validation process issued the qualifiers shown in the following table.

Qualifier	Reason Code	Count	Percent	Available as Reported	Available as Qualified	Impact on PARCC
[NONE]	[NONE]	266	77.78	X		none
J	[NONE]	43	12.57	X		none
B	EBL	19	5.56%		X	none
B	CCBL	3	0.88%		X	none
K	MSH	3	0.88%		X	none
B	MBL	3	0.88%		X	none
J	FD	2	0.58%		X	none
U	[NONE]	2	0.58%	X		none
UL	MSL	1	0.29%		X	none
		342	100.00%	90.93%	9.07%	

100.00% not R-flagged and available for use

All data is of sufficient quality to evaluate whether action limits were met.

##### Screening Data

Grain-size, total organic carbon, and pH were measured in almost all surface soil samples by the methods specified in the AOC 6 SAP (ASTM D422, Lloyd Kahn, and SW-846 9045D, respectively). The data review process issued the qualifiers shown in the following table. The screening dataset is 100% complete and available for use as screening data.

Qualifier	Reason Code	Count	Percent	Available as Reported	Impact on PARCC
[NONE]	[NONE]	234	100%	X	none
		234	100.00%	100.00%	

100.00% not R-flagged and available for use

### E.4.1.3 Subsurface Soil

#### Organics Data

Explosives were analyzed by the methods specified in the AOC 6 SAP (SW-846 8330B). The validation process issued the qualifiers shown in the following table.

Qualifier	Reason Code	Count	Percent	Available as Reported	Available as Qualified	Not Available	Impact on PARCC
U	[NONE]	219	92.02	X			none
[NONE]	[NONE]	17	7.14%	X			none
R	MSL	1	0.42%			X	Accuracy, Completeness
UL	MSL	1	0.42%		X		none
		238	100.00%	99.16%	0.84%		

99.58% not R-flagged and available for use

Data was R-qualified for low matrix spike recovery (MSL) of nitroglycerin in one sample (CAA06-SO26-0H02-0913). Additionally, this sample had one UL qualification for explosives (PETN). Except for the R-qualified results, all data are available as reported by the laboratory or as qualified by the validator. The R-qualified result is not available as a detection or nondetection, however, explosives data for the remaining subsurface soil samples is available for decision-making; therefore, the impact on data completeness is not very significant. All in all, the data for organics in AOC 6 subsurface soil is of good quality and exceeds the typical completeness goal of 95%.

#### Inorganics Data

Metals, including hexavalent chromium, mercury, and cyanide, were analyzed in subsurface soil by the methods specified in the AOC 6 SAP (SW-846 6010C, 6020A, 7199, 7471B, and 9014 respectively). The validation process issued the qualifiers shown in the following table.

Qualifier	Reason Code	Count	Percent	Available as Reported	Available as Qualified	Impact on PARCC
[NONE]	[NONE]	261	76.32%	X		none
J	[NONE]	43	12.57%	X		none
U	[NONE]	6	1.75%	X		none
B	EBL	21	6.14%		X	none
L	MSL	4	1.17%		X	none
B	CCBL	2	0.58%		X	none
B	MBL	2	0.58%		X	none
J	FD	2	0.58%		X	none
K	MSH	1	0.29%		X	none
		345	100.00%	90.64%	9.36%	

Select results for CAA06-SB36-0H02-0913 were detected below the PAL, but were qualified as biased low (L-qualified). These results are shown in **Table 4-1**. True concentrations may be higher, and the possibility that concentrations exceed the PAL should be taken into consideration when using the data.

### Screening Data

pH and TOC were analyzed in subsurface soil by the methods specified in the AOC 6 SAP (SW-846 9045D and Lloyd Kahn respectively). The data review process issued the qualifiers shown in the following table. The screening dataset is 100% complete and available for use as screening data.

Qualifier	Reason Code	Count	Percent	Available as Reported	Impact on PARCC
[NONE]	[NONE]	26	100%	X	none
		26	100.00%	100.00%	

100.00% not R-flagged and available for use

## E.5 Conclusions

The data user may express confidence in the fact that the data for Cheatham Annex AOC 6, is comparable to others of acceptable data quality because approved SOPs were used for sample collection and handling, common sample matrices were evaluated, and EPA methods were utilized.

With the exception of data that has been rejected due to quality exceedances, precision, accuracy, representativeness, and completeness were demonstrated to be acceptable and the data user may be confident that this dataset is comparable to others of high data quality. Of any media and analytical group, the dataset that is least complete is Organics in Subsurface Soils, however even that dataset was 99.58% complete. As a whole, the AOC 6 dataset is 99.94% complete, such that the 0.06% of data that is unavailable has negligible impact on the quality of the dataset. No completeness goal was specified in the SAP (CH2M HILL, 2013), but this far exceeds the typical 95% completeness goal.

## E.6 References

- CH2M HILL. 2013. *AOC 6 TNT Graining House and TNT Catch Box Ruins Subareas – Remedial Investigation Tier II Sampling and Analysis Plan*. August.
- EPA. 1989. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual*. EPA/540/1-89/002, Part A, October.
- USEPA. 1993. *USEPA Contract Laboratory Program Region III Modification to National Functional Guidelines for Inorganic Data Review, Multi Media Multi Concentration*. April.
- USEPA. 1994. *USEPA Contract Laboratory Program Region III Modification to National Functional Guidelines for Organic Data Review, Multi Media Multi Concentration*. September.

TABLE 3-2

## Nondetect Results Reported at Value Greater than the Comparison Criteria

*Inorganics in AOC 6 Groundwater*

DL meets Action Limit?	Sample Name	Analysis Group	Analyte Name	CAS Number	Analytical Result	Units	Validator Qualifier	Qualifier Reason Code	DL	LOD	LOQ	Minimum PAL or Background
No	CAA06-GW01P-1013	METAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW05-1013	METAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW02-1013	METAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW01-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW01P-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW02-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW03-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW04-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW06-1013	METAL	Cyanide	57-12-5	4.00	UG_L	U		1.00	4.00	10.0	0.15
No	CAA06-GW03-1013	FMETAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW05-1013	FMETAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW02-1013	FMETAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW06-1013	FMETAL	Chromium	7440-47-3	0.50	UG_L	U		0.2	0.50	1.0	0.035
No	CAA06-GW01P-1013	FMETAL	Thallium	7440-28-0	0.10	UG_L	U		0.027	0.10	1.0	0.02
No	CAA06-GW03-1013	FMETAL	Thallium	7440-28-0	0.10	UG_L	U		0.027	0.10	1.0	0.02
No	CAA06-GW04-1013	FMETAL	Thallium	7440-28-0	0.10	UG_L	U		0.027	0.10	1.0	0.02
No	CAA06-GW02-1013	FMETAL	Thallium	7440-28-0	0.10	UG_L	U		0.027	0.10	1.0	0.02

TABLE 4-1

## Detections Below the PAL with Low Bias

*Inorganics in Cheatham Annex AOC 6 Surface and Subsurface Soil*

Sample Name	Analytical Method	Analyte Name	CAS Number	Analytical Result	Units	Validator Qualifier	Qualifier Reason Code	DL	LOD	LOQ	Minimum PAL or Background
CAA06-SB36-0H02-0913	6020A	Selenium	7782-49-2	0.36	MG_KG	L	MSL	0.031	0.094	0.094	0.52
CAA06-SB36-0H02-0913	9014	Cyanide	57-12-5	0.084	MG_KG	L	MSL	0.026	0.059	0.12	2.1

## Appendix F

### Slug Test Plots

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**Table F-1**K<sub>h</sub> Values from Slug Tests

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Monitoring Well	CAA06-MW01				CAA06-MW02			
Falling/Rising Head Test	MW01 FH1	MW01 FH2	MW01 RH1	MW01 RH2	MW02 FH1	MW02 FH2	MW02 RH1	MW02 RH2
BR K (ft/s)	9.07E-06	6.21E-06	8.38E-06	8.19E-06	9.18E-06	1.46E-05	2.04E-05	1.28E-05
BR y (ft)	0.4016	0.3569	0.7496	0.5726	0.7424	0.3774	0.7277	0.3418
HV K (ft/s)	1.36E-05	9.59E-06	1.33E-05	1.12E-05	1.34E-05	2.18E-05	2.48E-05	2.06E-05
HV y (ft)	0.4123	0.3682	0.7627	0.5819	0.7387	0.3747	0.5653	0.3648

MW01	Min	6.21E-06	MW02	Min	9.18E-06
	Max	1.36E-05		Max	2.48E-05
	Average	9.94E-06		Average	1.72E-05

Notes:

Shading indicates minimum or maximum K<sub>h</sub> valueAverage K<sub>h</sub> of all 6 wells = 0.962

**Table F-1**K<sub>h</sub> Values from Slug Tests

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Monitoring Well	CAA06-MW-3				CAA06-MW04			
Falling/Rising Head Test	MW03 FH1	MW03 FH2	MW03 RH1	MW03 RH2	MW04 FH1	MW04 FH2	MW04 RH1	MW04 RH2
BR K (ft/s)	3.01E-06	5.00E-06	1.51E-06	2.97E-06	1.45E-05	1.38E-05	6.50E-06	6.52E-06
BR y (ft)	0.209	0.1011	0.18	0.1069	2	2.018	1.78	1.821
HV K (ft/s)	4.56E-06	6.47E-06	1.91E-06	4.47E-06	2.17E-05	1.84E-05	9.24E-06	8.54E-06
HV y (ft)	0.2157	0.09293	0.169	0.1061	2.025	1.926	1.841	1.625

MW03	Min	1.51E-06	MW04	Min	6.50E-06
	Max	6.47E-06		Max	2.17E-05
	Average	3.74E-06		Average	1.24E-05

Notes:

Shading indicates minimum or max

Average K<sub>h</sub> of all 6 wells =

**Table F-1**K<sub>h</sub> Values from Slug Tests

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

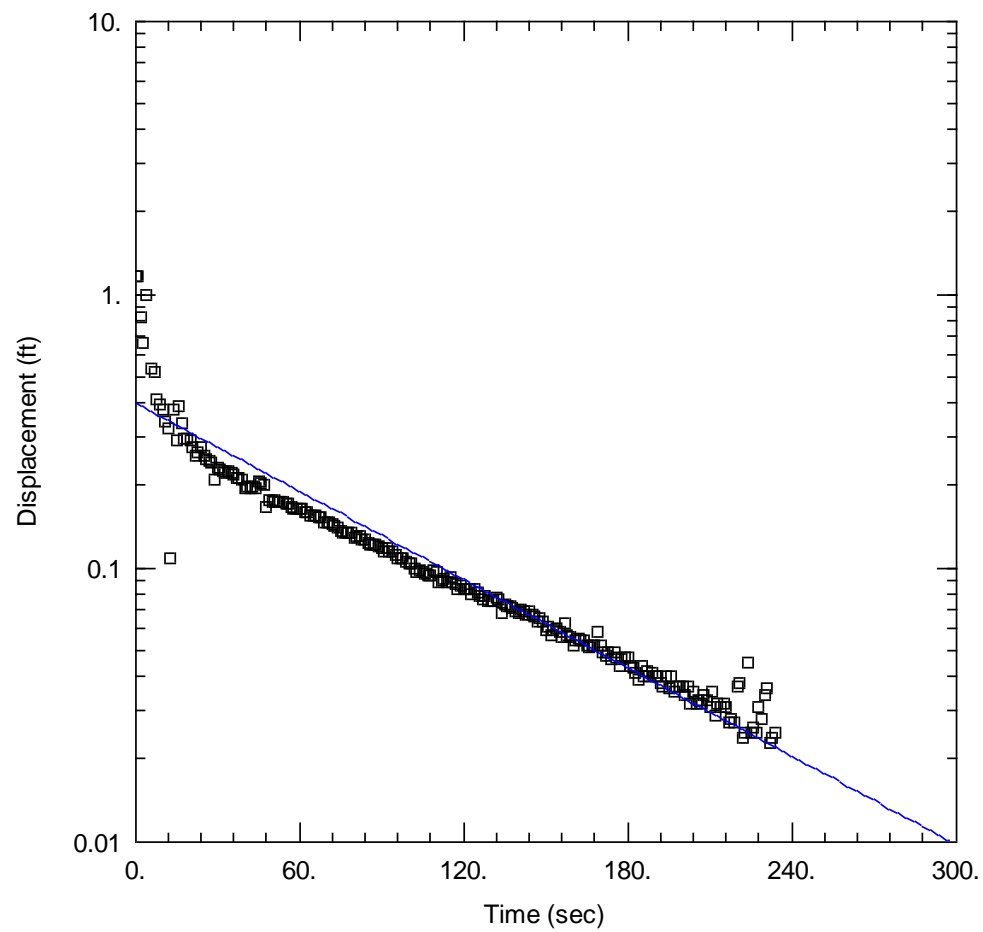
Monitoring Well	CAA06-MW05				CAA06-MW06			
Falling/Rising Head Test	MW05 FH1	MW05 FH2	MW05 RH1	MW05 RH2	MW06 FH1	MW06 FH2	MW06 RH1	MW06 RH2
BR K (ft/s)	6.36E-06	5.62E-06	8.33E-06	7.10E-06	2.02E-05	1.08E-05	8.28E-06	1.19E-05
BR y (ft)	0.4324	0.3709	0.702	0.6054	0.3937	0.255	0.3788	0.2704
HV K (ft/s)	1.01E-05	8.82E-06	1.08E-05	9.98E-06	2.59E-05	1.52E-05	1.25E-05	1.67E-05
HV y (ft)	0.4882	0.4097	0.7018	0.6357	0.3499	0.2521	0.39	0.2516

MW05	Min	5.62E-06	MW06	Min	8.28E-06
	Max	1.08E-05		Max	2.59E-05
	Average	8.38E-06		Average	1.52E-05

Notes:

Shading indicates minimum or max

Average K<sub>h</sub> of all 6 wells =



Obs. Wells

□ New Well

Aquifer Model

Unconfined

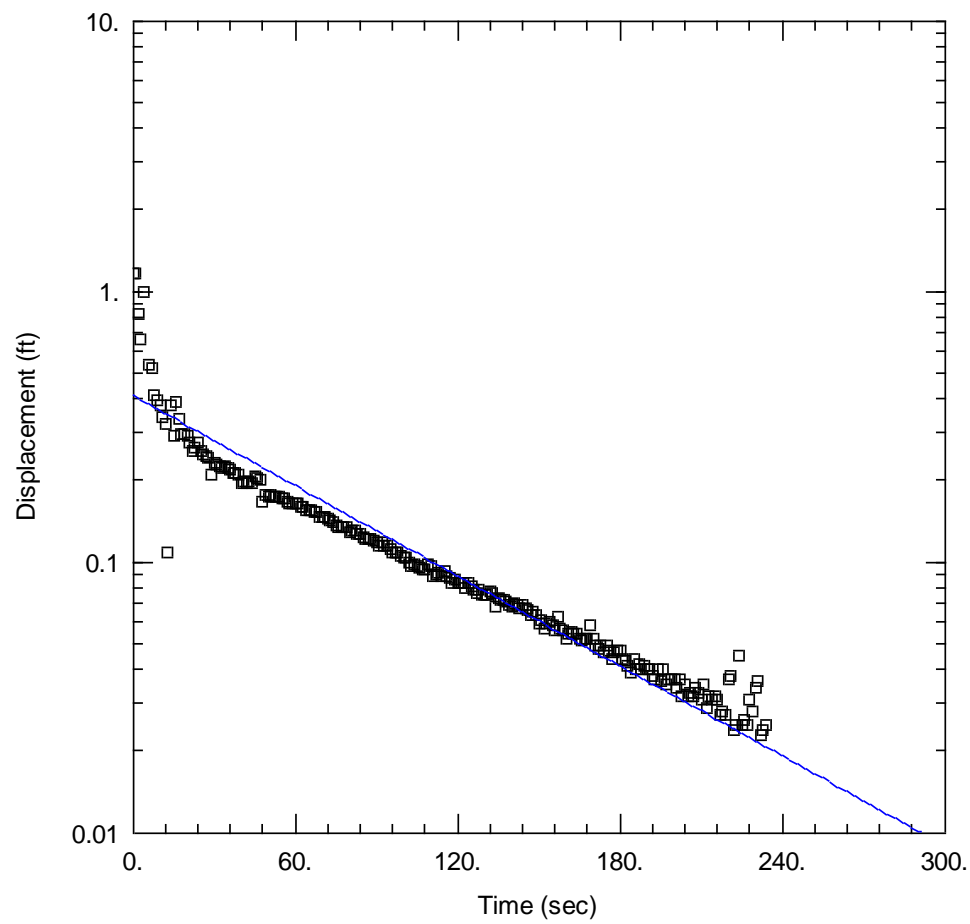
Solution

Bouwer-Rice

Parameters

$K = 9.07E-6$  ft/sec

$y_0 = 0.4016$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

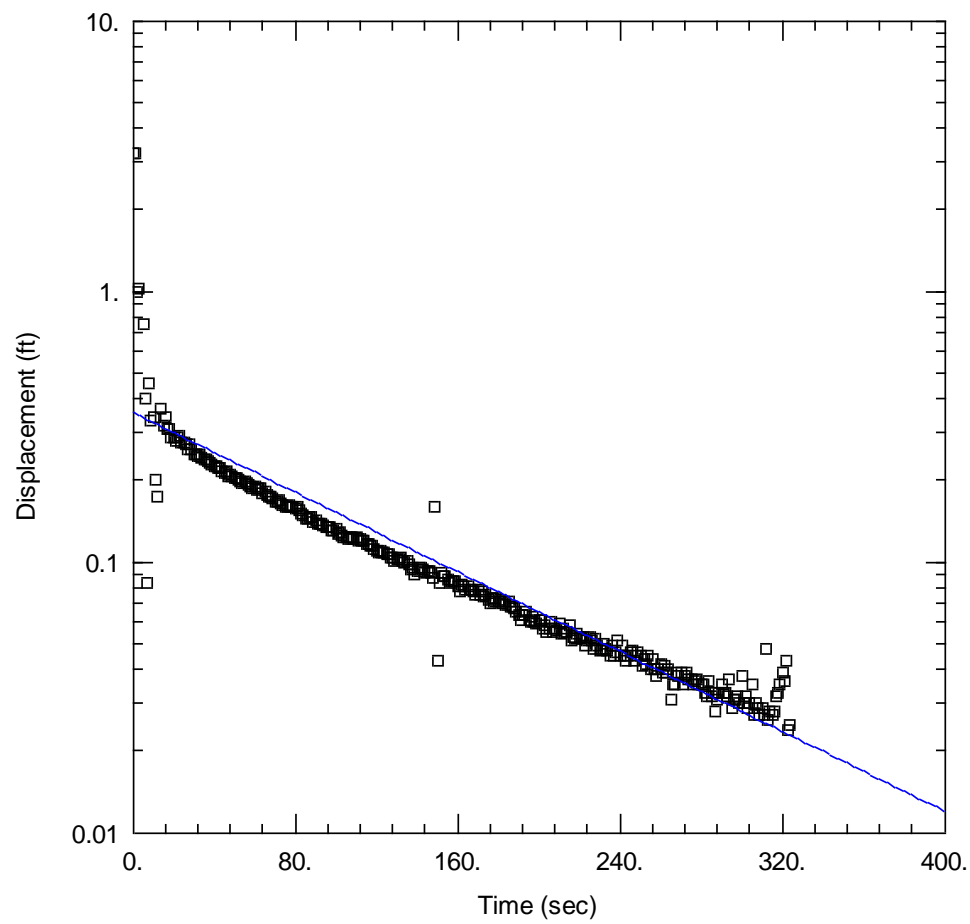
Solution

Hvorslev

Parameters

$K = 1.358E-5$  ft/sec

$y_0 = 0.4123$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

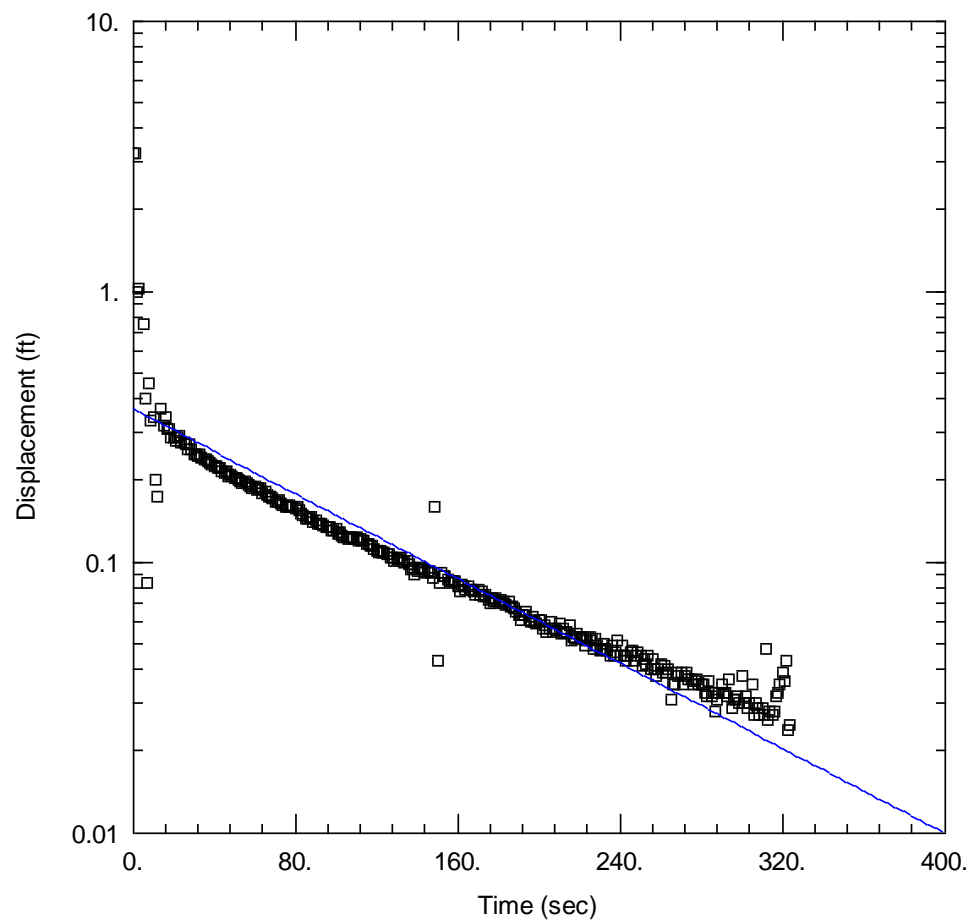
Solution

Bouwer-Rice

Parameters

$K = 6.205E-6$  ft/sec

$y_0 = 0.3569$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

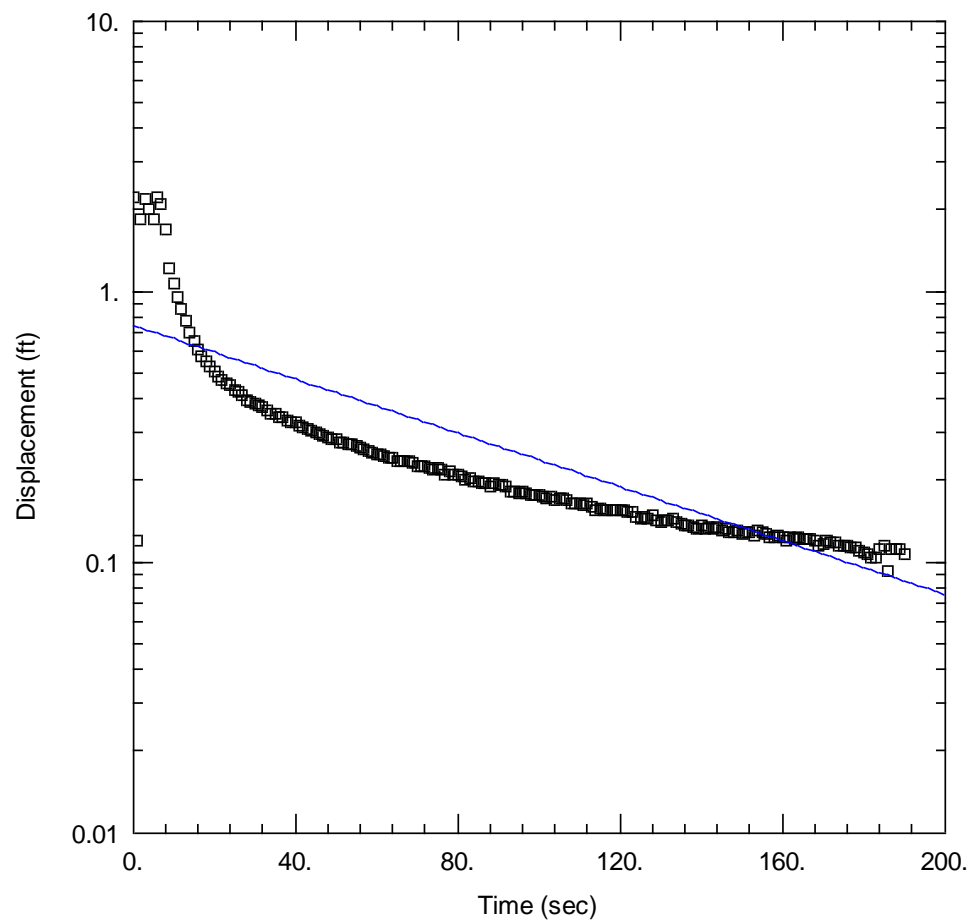
Solution

Hvorslev

Parameters

$K = 9.591\text{E-}6$  ft/sec

$y_0 = 0.3682$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

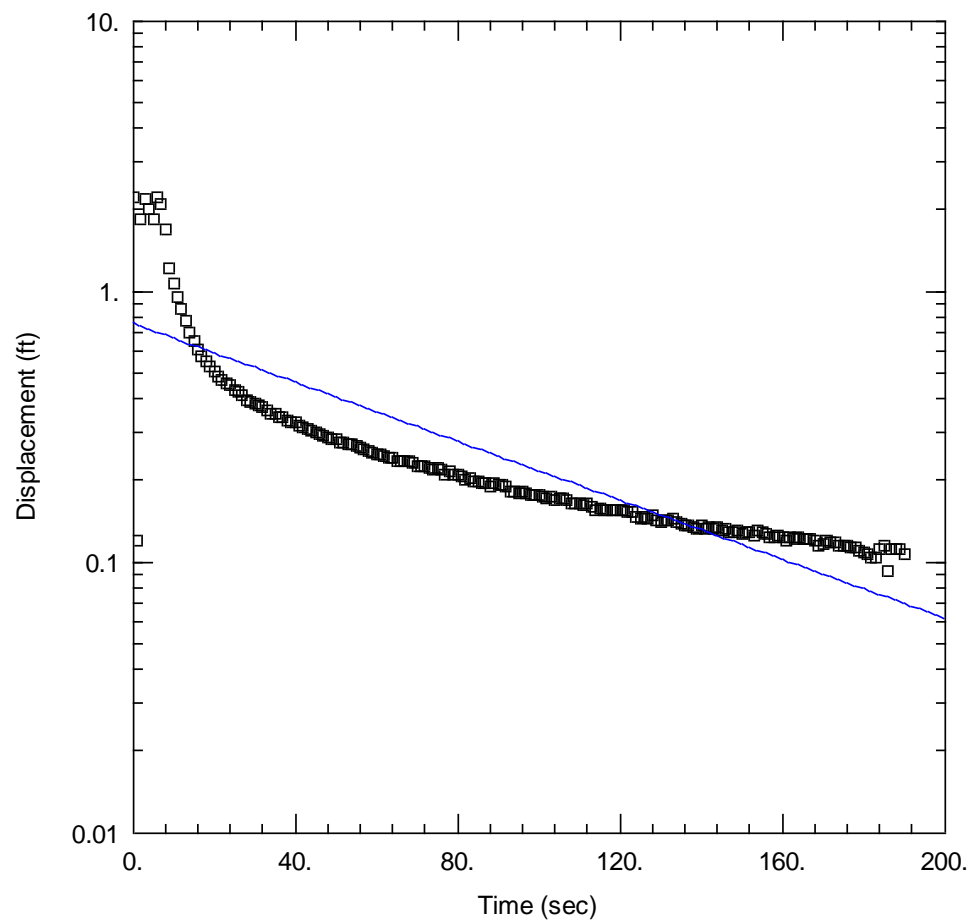
Solution

Bouwer-Rice

Parameters

$K = 8.377\text{E-}6$  ft/sec

$y_0 = 0.7496$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

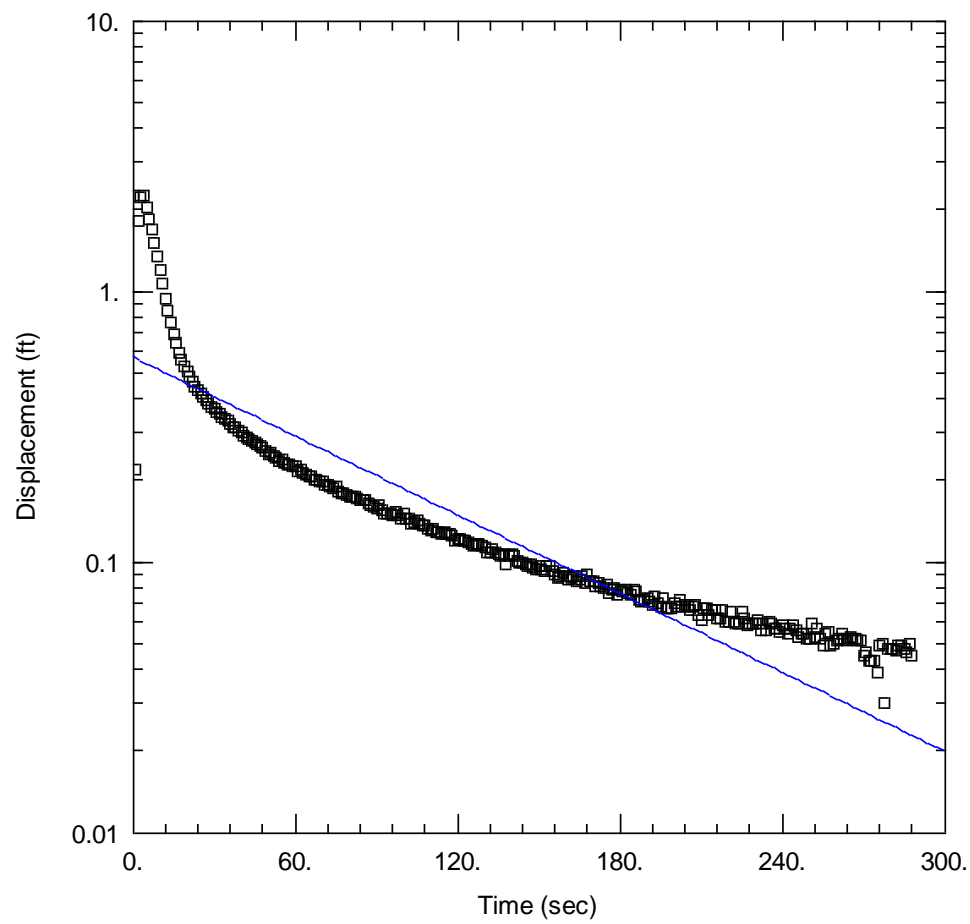
Solution

Hvorslev

Parameters

$K = 1.334\text{E-}5 \text{ ft/sec}$

$y_0 = 0.7627 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

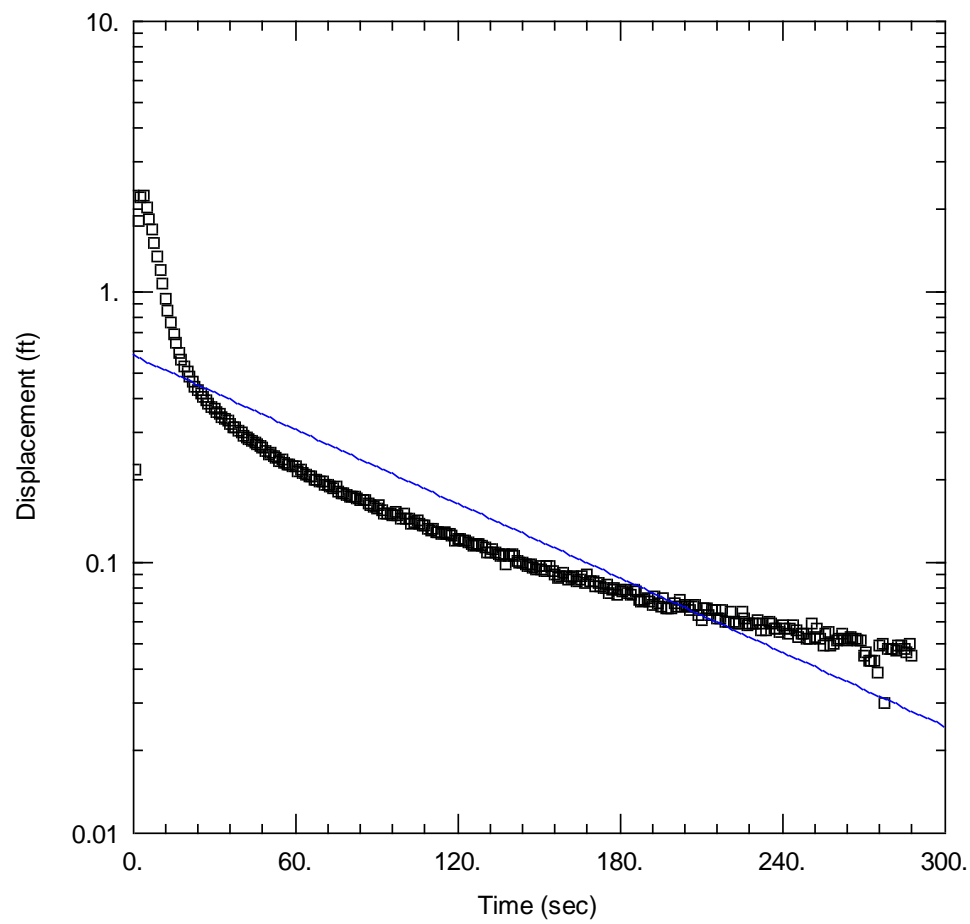
Solution

Bouwer-Rice

Parameters

$K = 8.187\text{E-}6 \text{ ft/sec}$

$y_0 = 0.5726 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

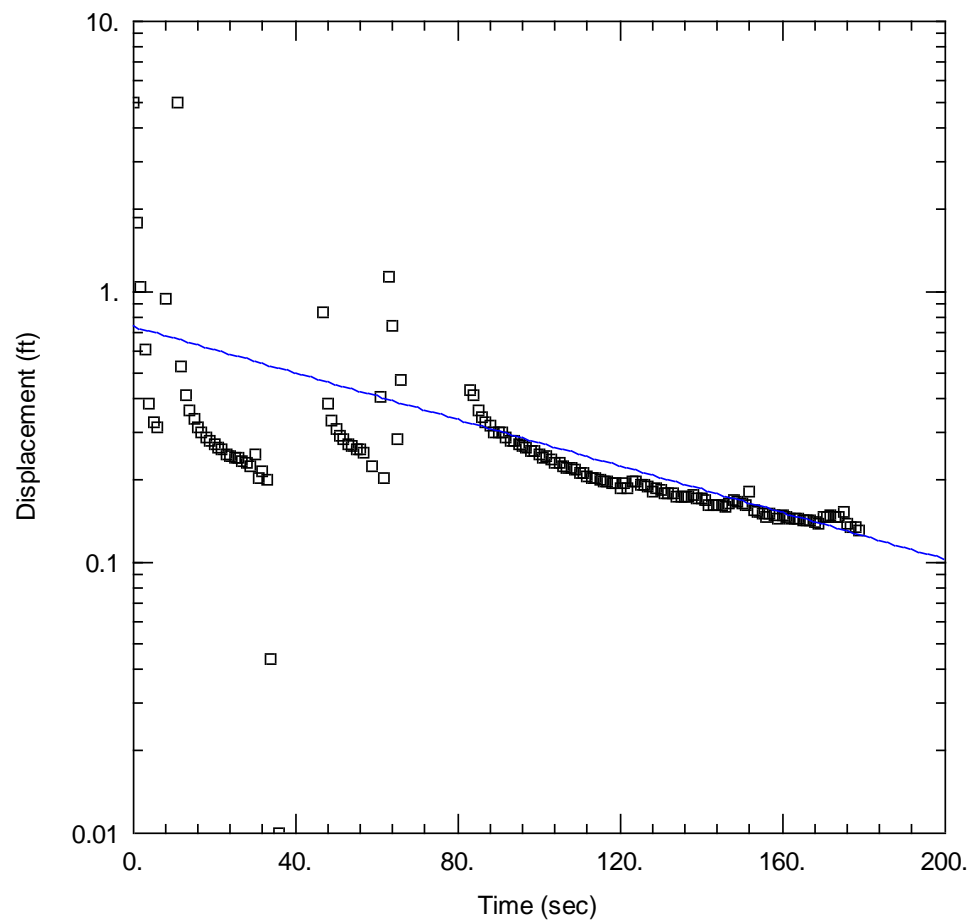
Solution

Hvorslev

Parameters

$K = 1.119\text{E-}5 \text{ ft/sec}$

$y_0 = 0.5819 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

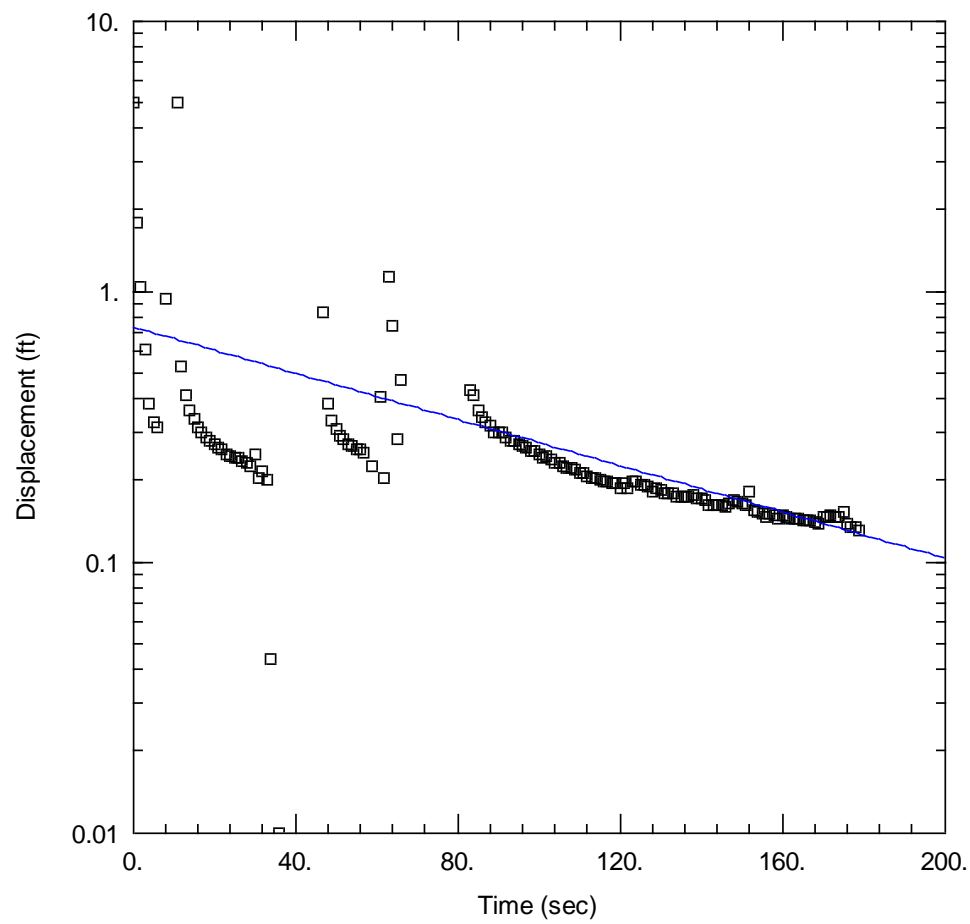
Solution

Bouwer-Rice

Parameters

$K = 9.176\text{E-}6 \text{ ft/sec}$

$y_0 = 0.7424 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

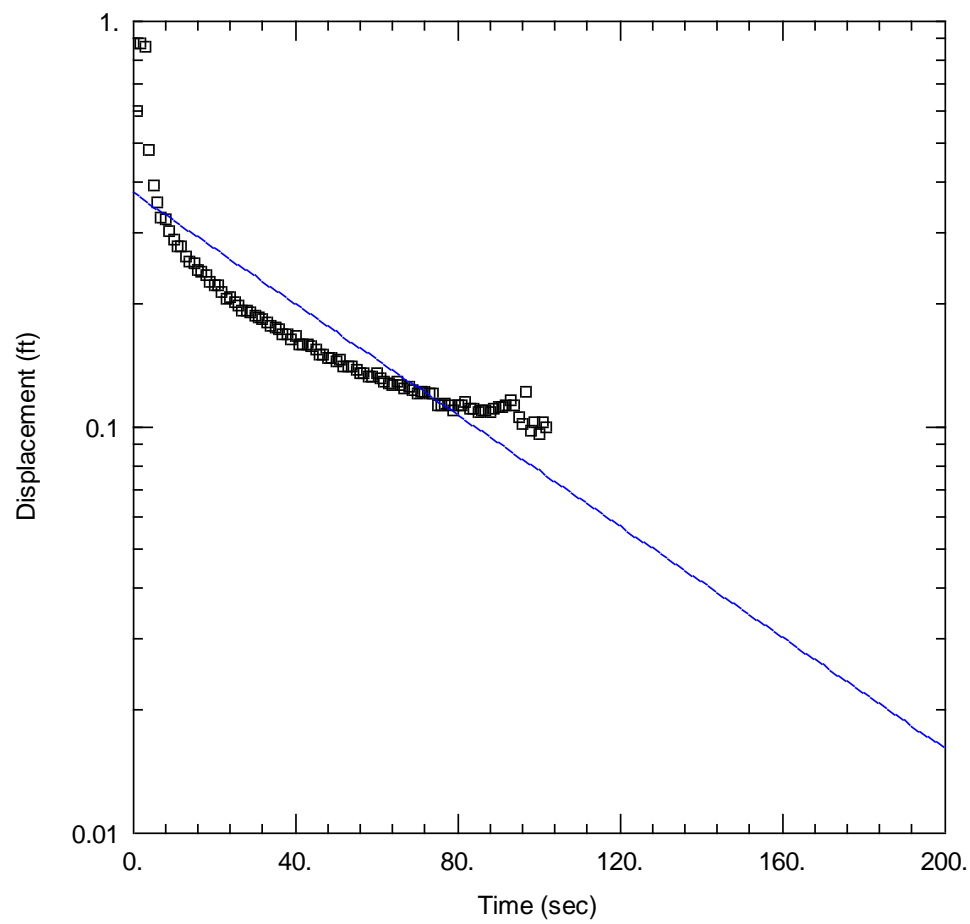
Solution

Hvorslev

Parameters

$K = 1.339\text{E-}5 \text{ ft/sec}$

$y_0 = 0.7387 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

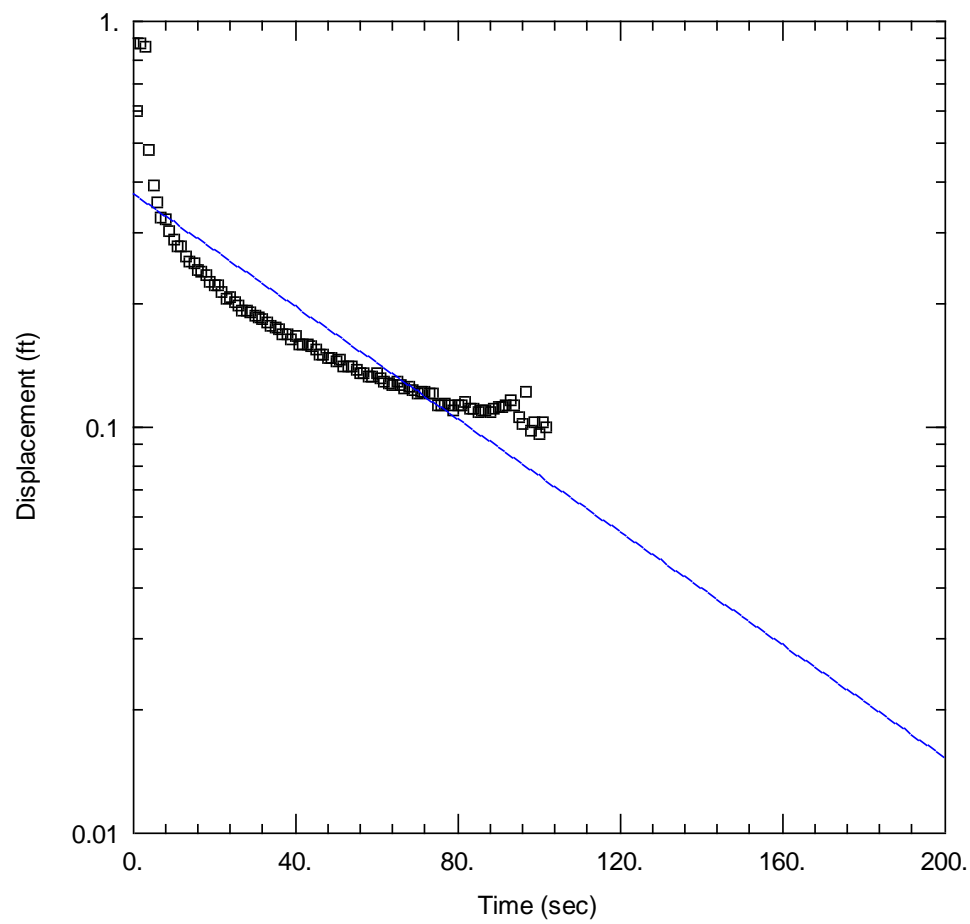
Solution

Bouwer-Rice

Parameters

$K = 1.461\text{E-}5 \text{ ft/sec}$

$y_0 = 0.3774 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

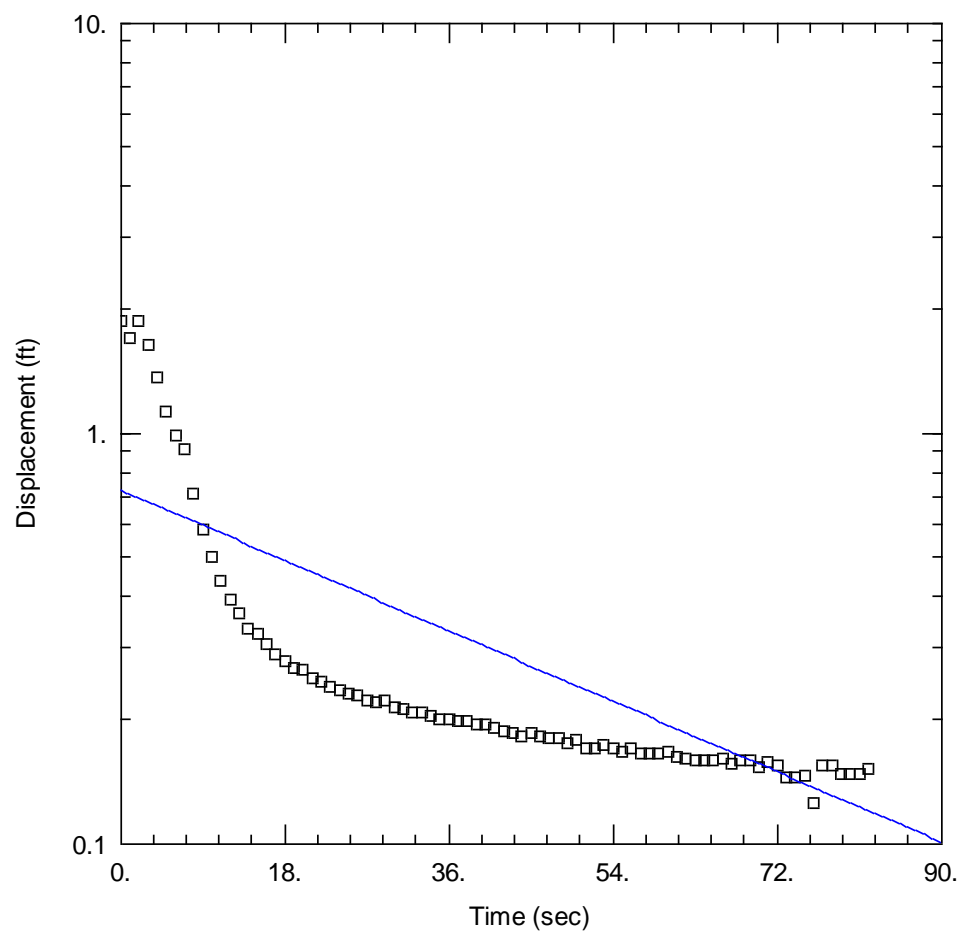
Solution

Hvorslev

Parameters

$K = 2.176E-5$  ft/sec

$y_0 = 0.3747$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

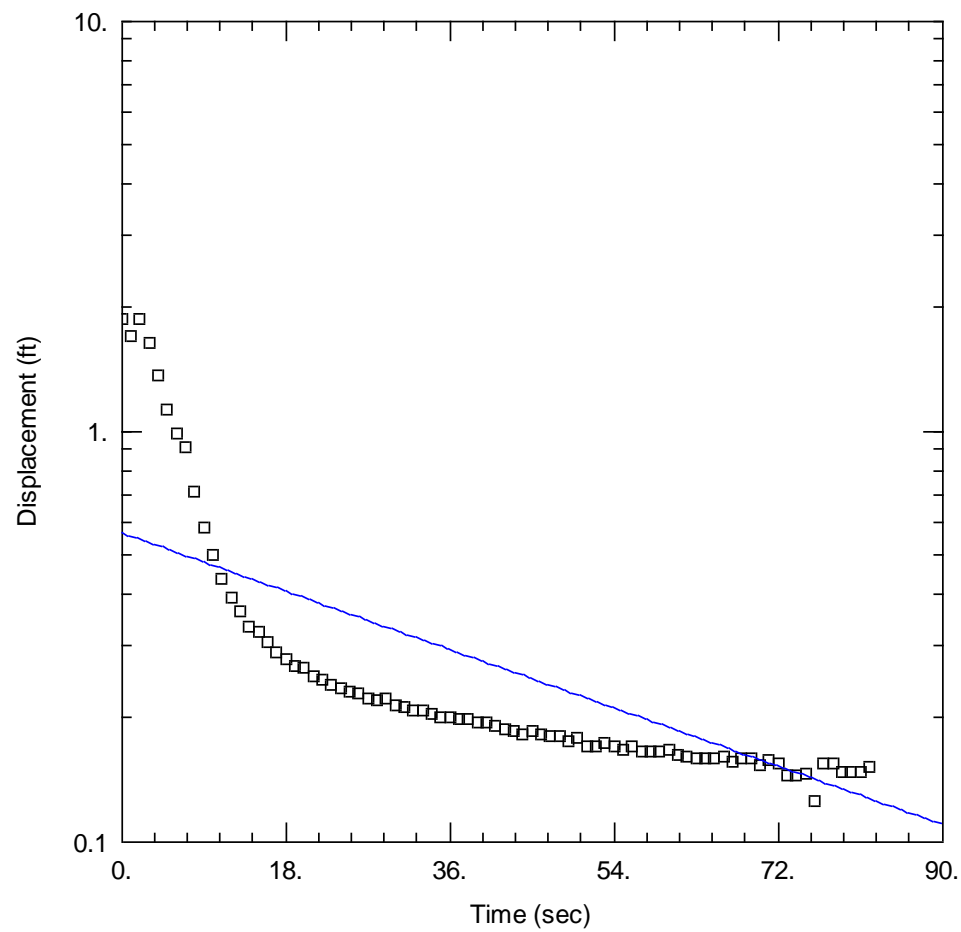
Solution

Bouwer-Rice

Parameters

$K = 2.035E-5$  ft/sec

$y_0 = 0.7277$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

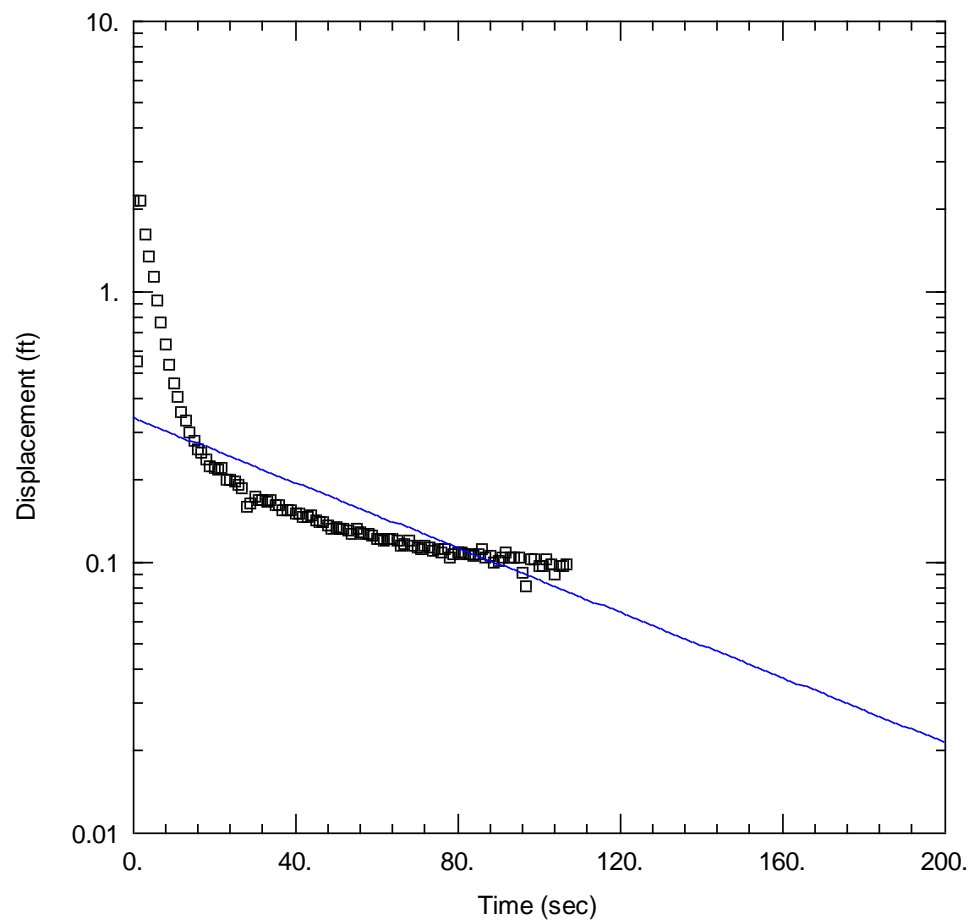
Solution

Hvorslev

Parameters

$K = 2.475E-5$  ft/sec

$y_0 = 0.5653$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

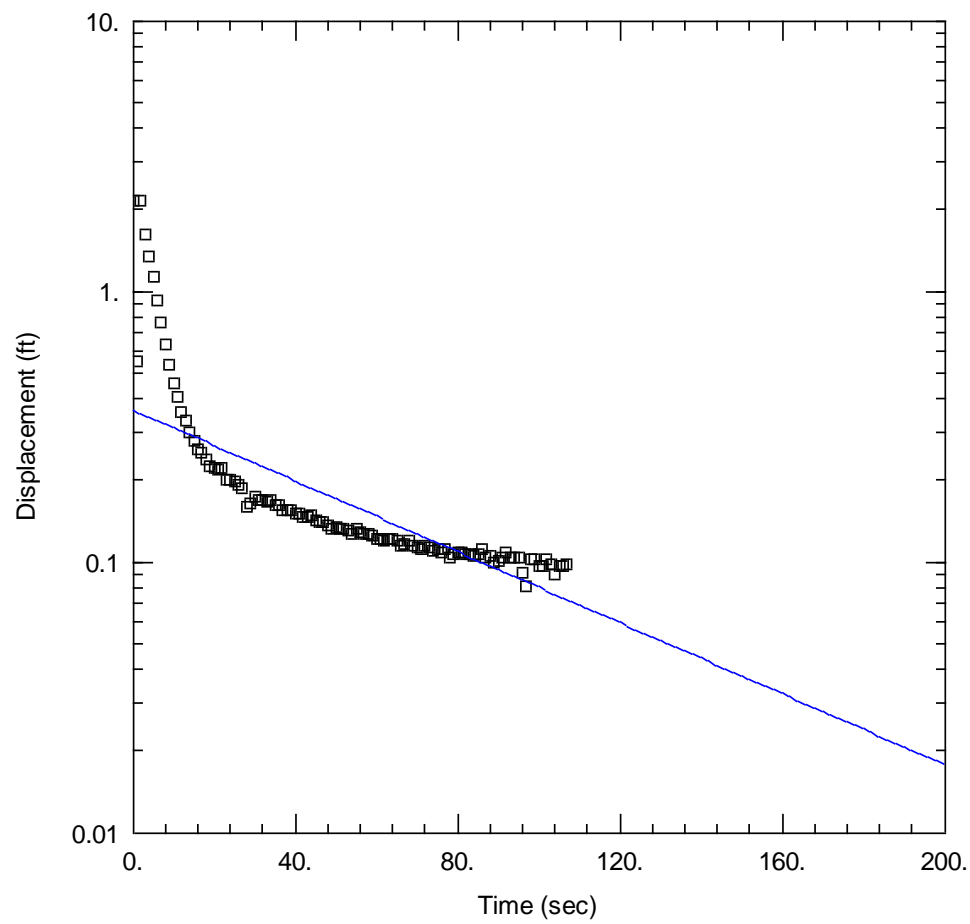
Solution

Bouwer-Rice

Parameters

$K = 1.281\text{E-}5$  ft/sec

$y_0 = 0.3418$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

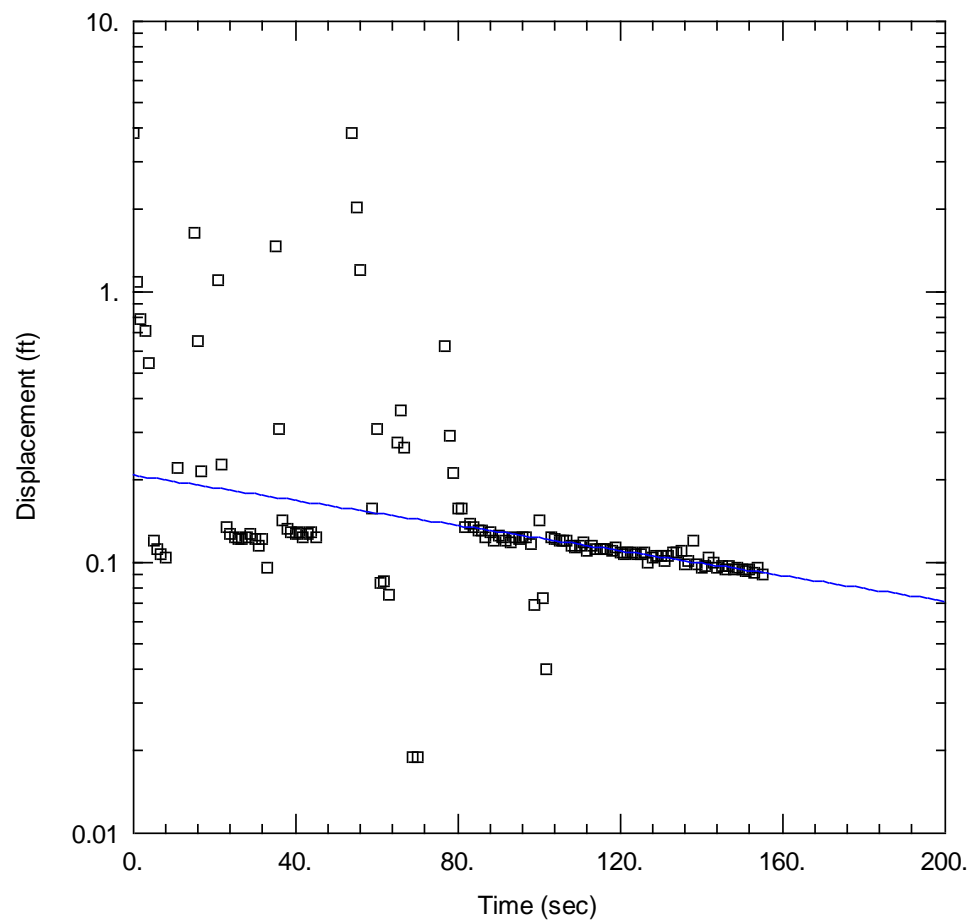
Solution

Hvorslev

Parameters

$K = 2.055E-5$  ft/sec

$y_0 = 0.3648$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

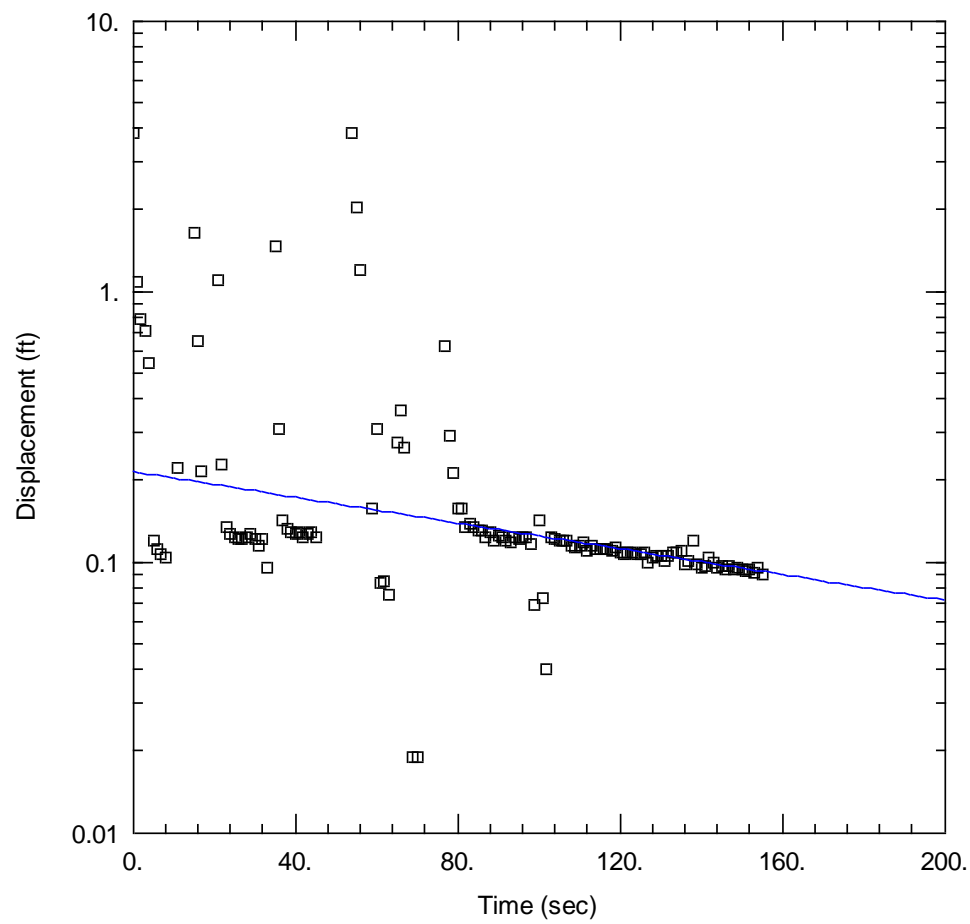
Solution

Bouwer-Rice

Parameters

$K = 3.011\text{E-}6 \text{ ft/sec}$

$y_0 = 0.209 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

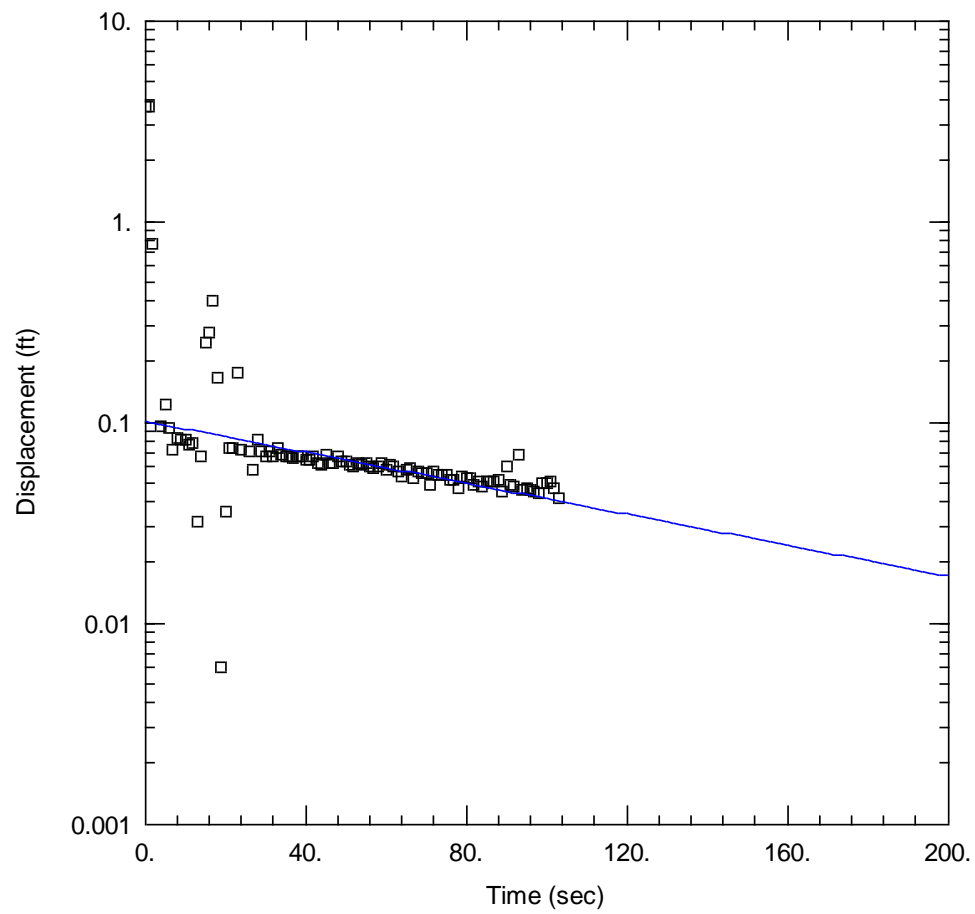
Solution

Hvorslev

Parameters

$K = 4.558\text{E-}6 \text{ ft/sec}$

$y_0 = 0.2157 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

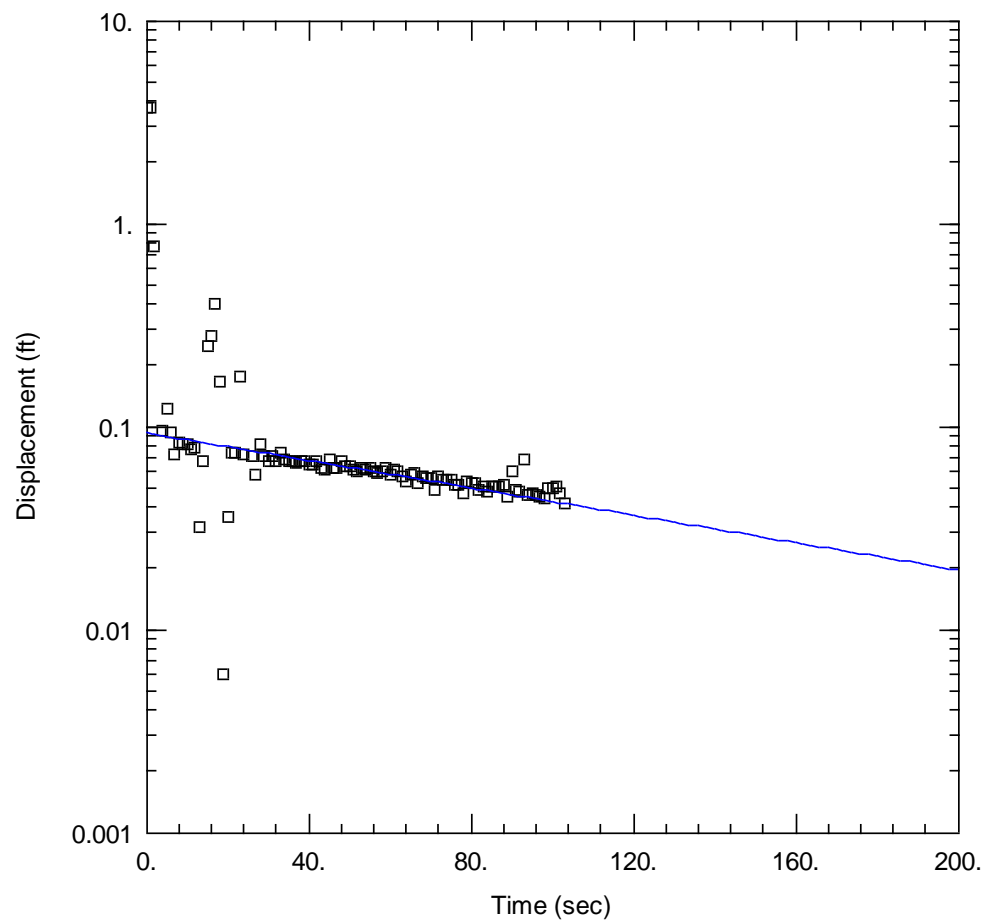
Solution

Bouwer-Rice

Parameters

$K = 5.003E-6$  ft/sec

$y_0 = 0.1011$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

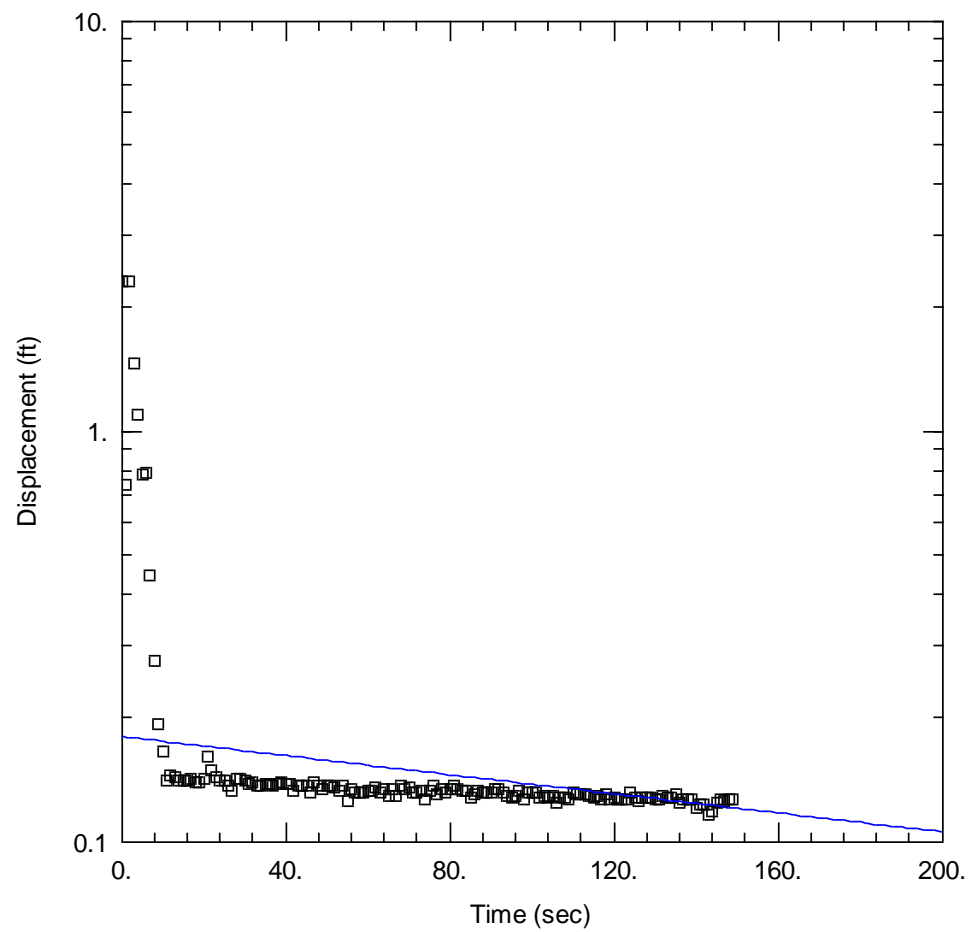
Solution

Hvorslev

Parameters

$K = 6.47E-6$  ft/sec

$y_0 = 0.09293$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

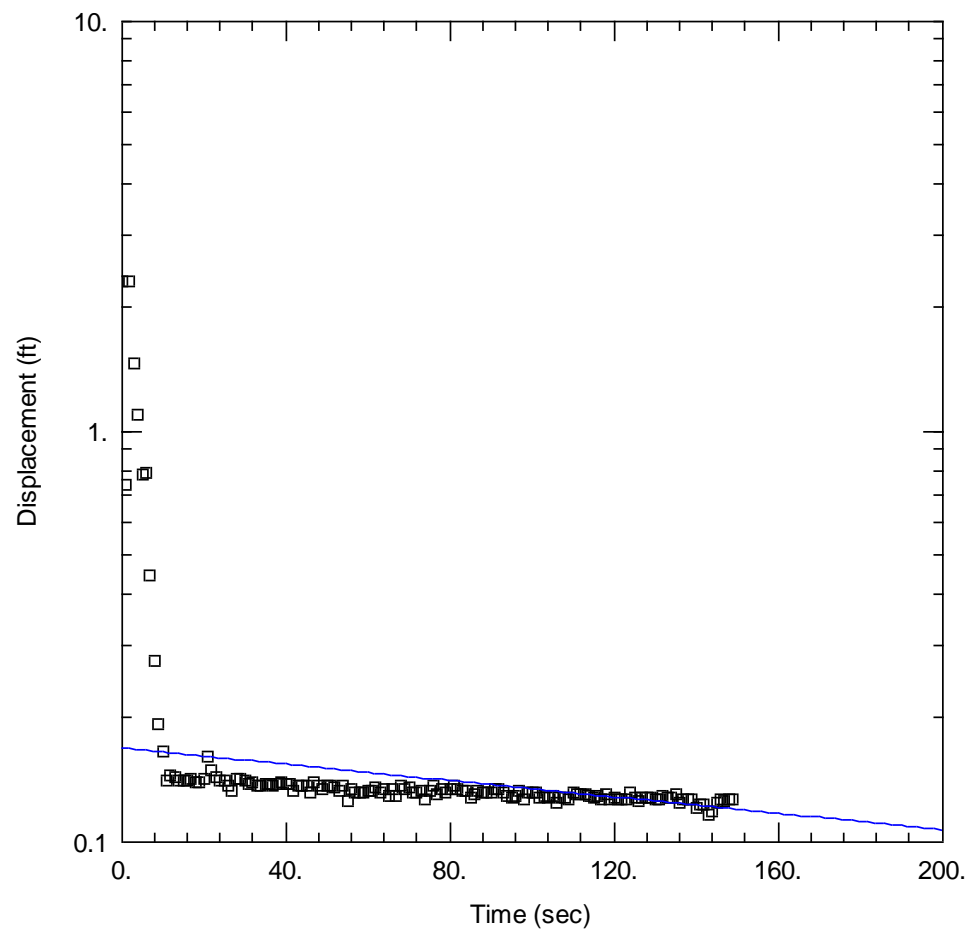
Solution

Bouwer-Rice

Parameters

$K = 1.508E-6$  ft/sec

$y_0 = 0.18$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

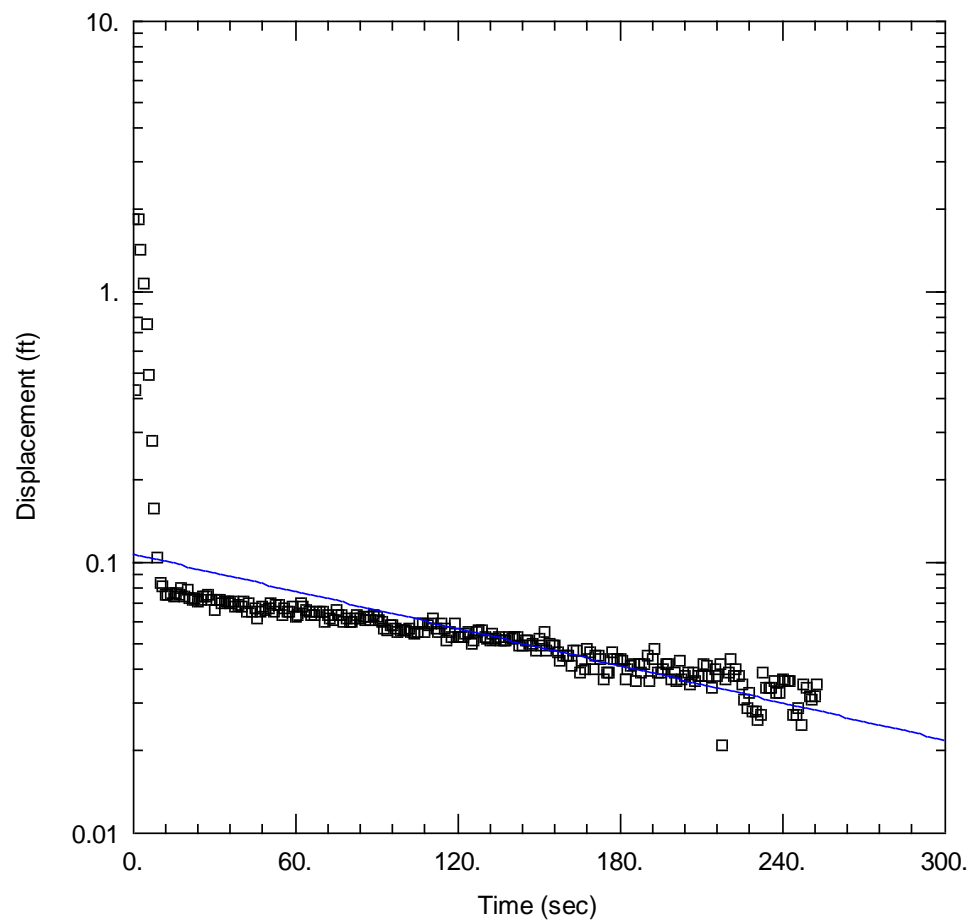
Solution

Hvorslev

Parameters

$K = 1.911\text{E-}6 \text{ ft/sec}$

$y_0 = 0.169 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

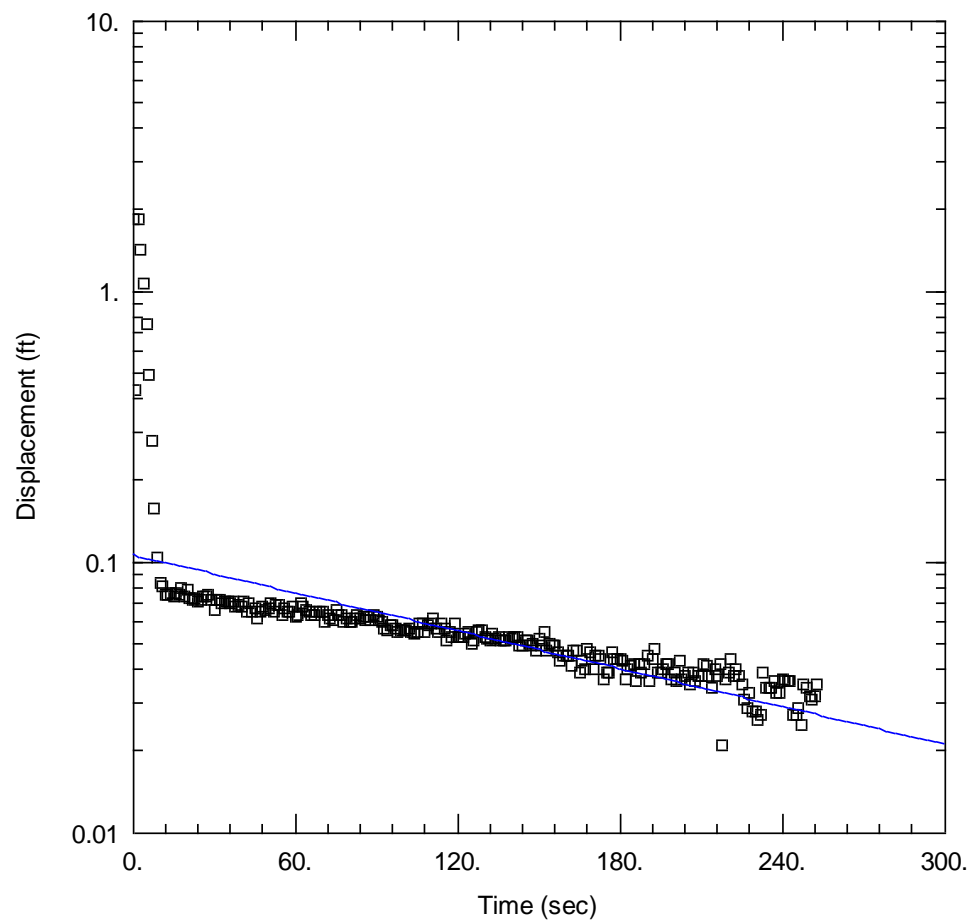
Solution

Bouwer-Rice

Parameters

$K = 2.971\text{E-}6$  ft/sec

$y_0 = 0.1069$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

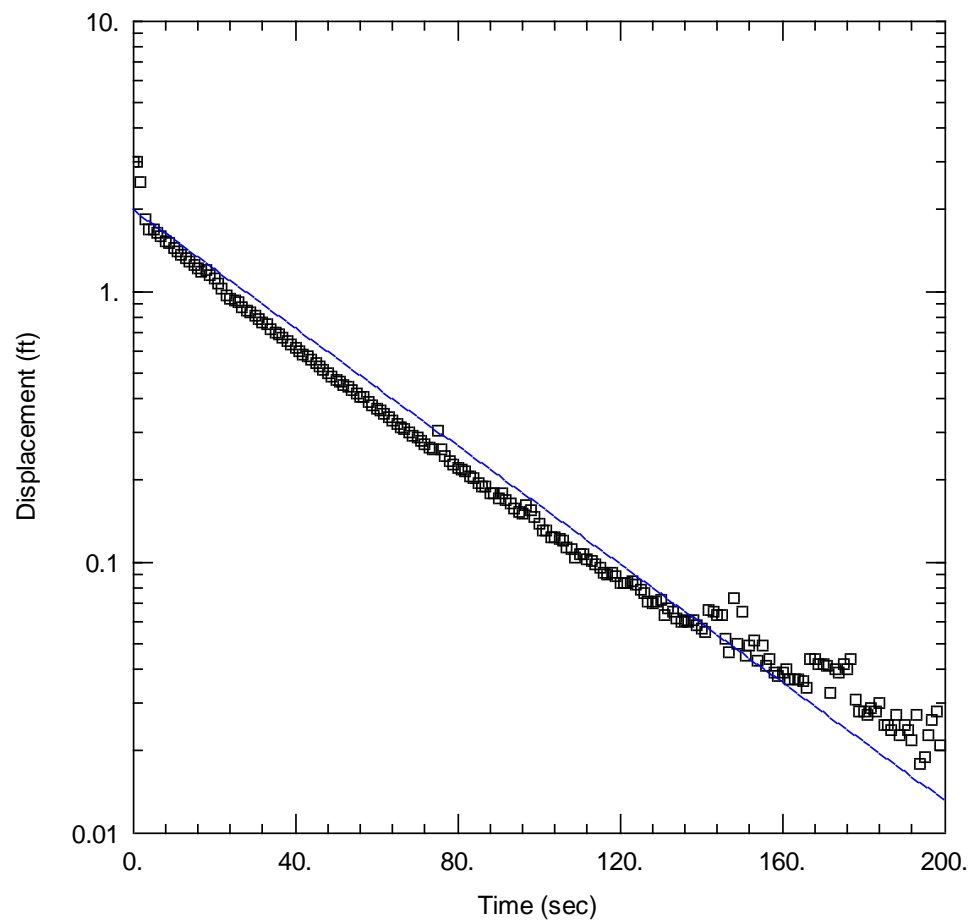
Solution

Hvorslev

Parameters

$K = 4.472\text{E-}6$  ft/sec

$y_0 = 0.1061$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

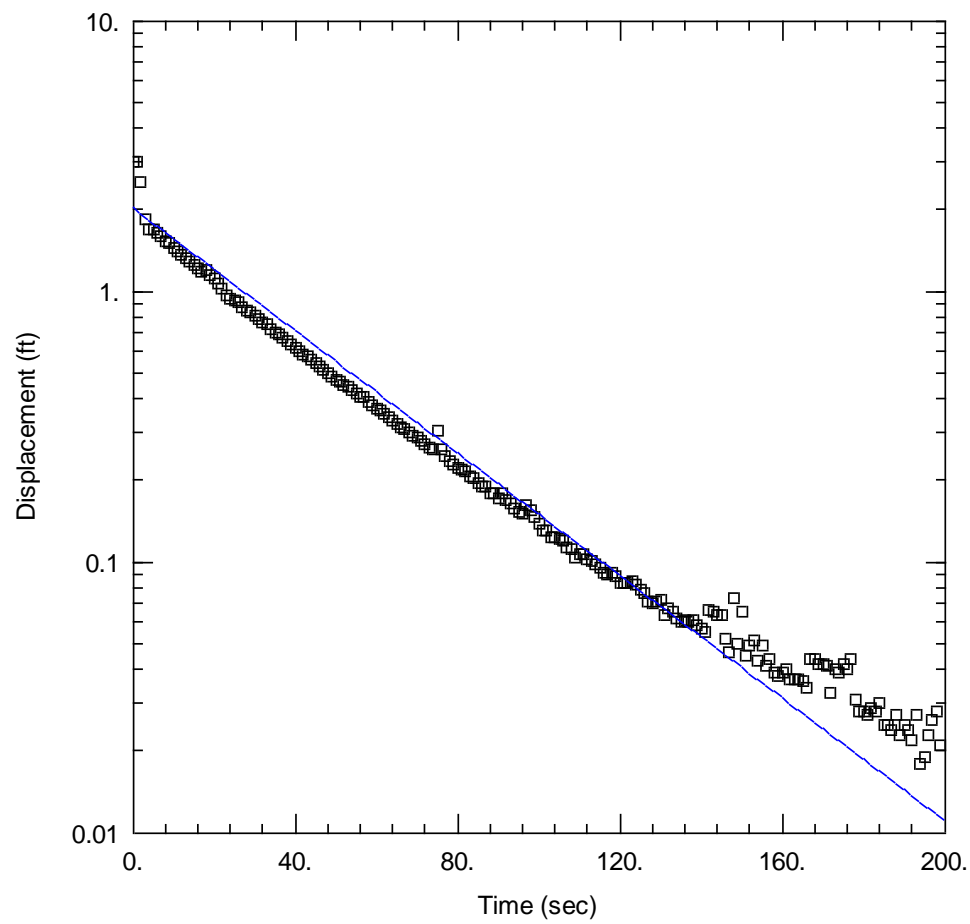
Solution

Bouwer-Rice

Parameters

$K = 1.448\text{E-}5 \text{ ft/sec}$

$y_0 = 2. \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

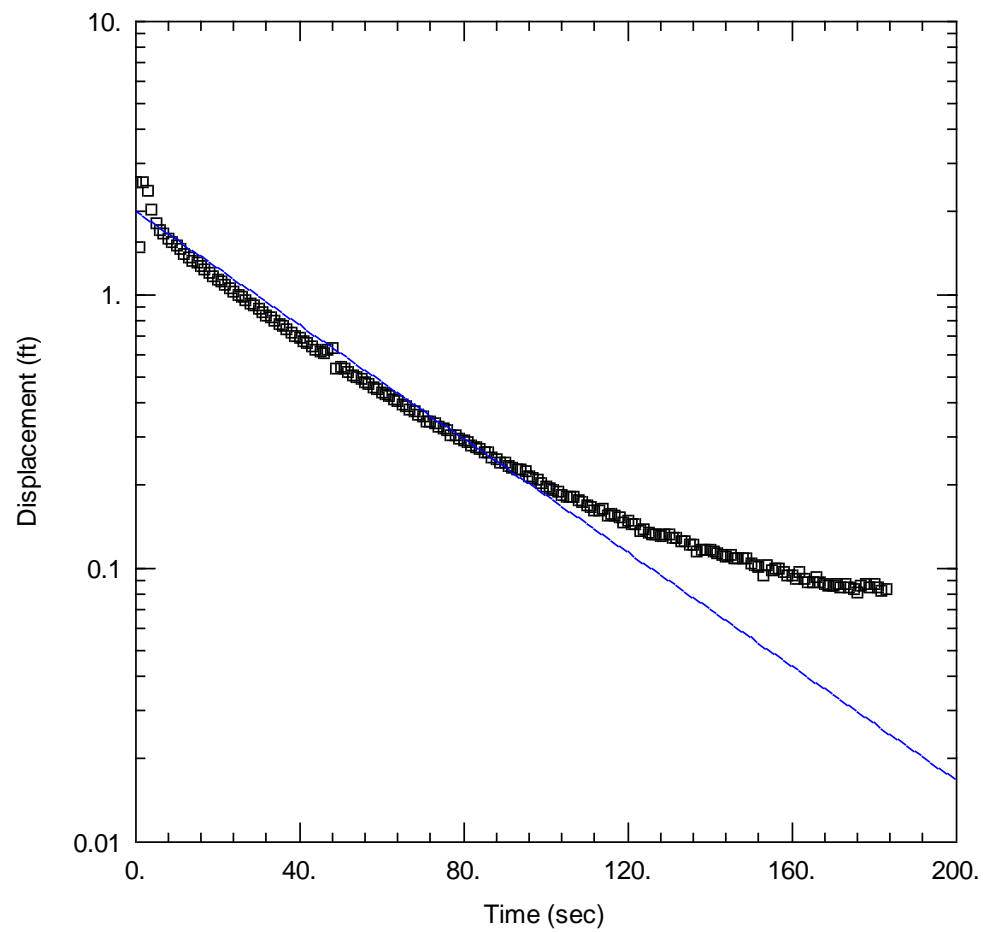
Solution

Hvorslev

Parameters

$K = 2.168E-5$  ft/sec

$y_0 = 2.025$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

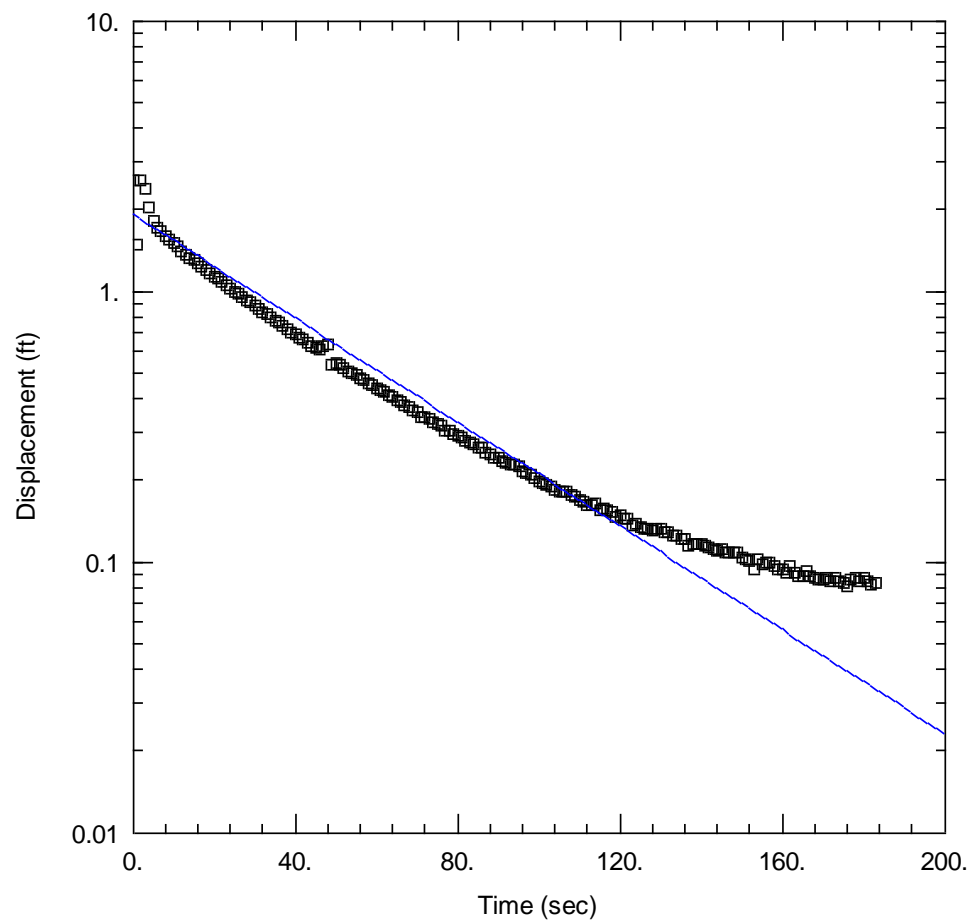
Solution

Bouwer-Rice

Parameters

$K = 1.38E-5$  ft/sec

$y_0 = 2.018$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

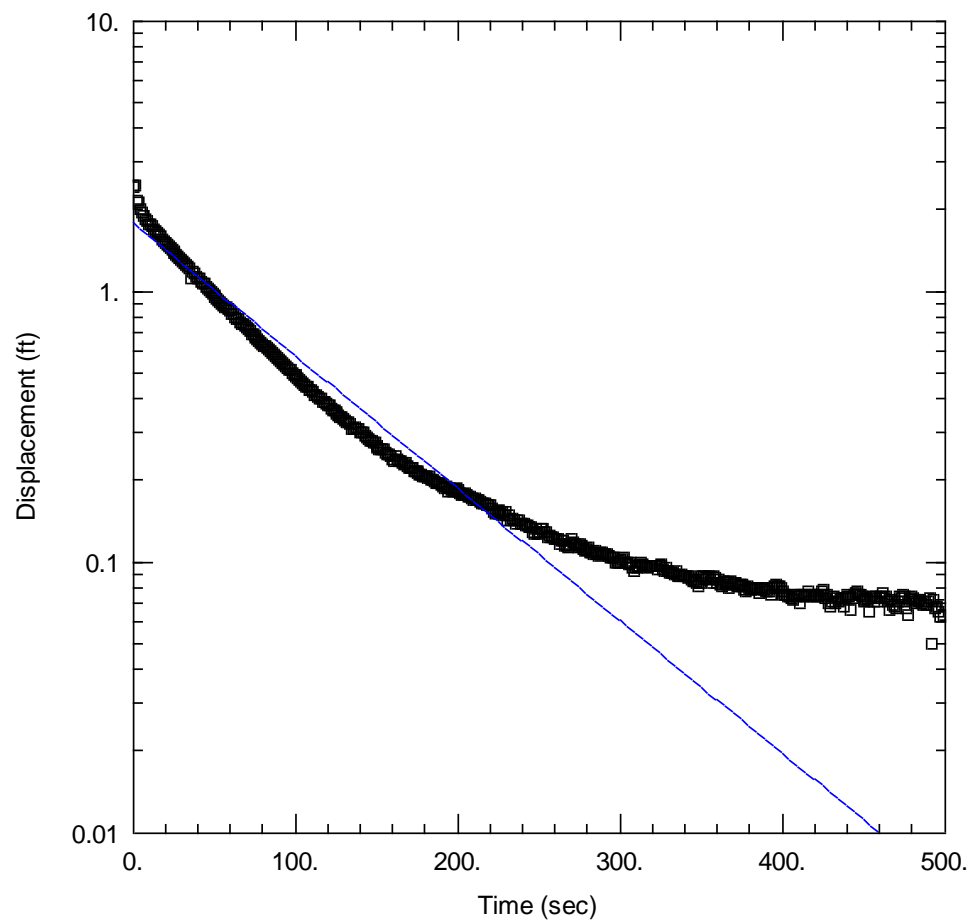
Solution

Hvorslev

Parameters

$K = 1.839\text{E-}5$  ft/sec

$y_0 = 1.926$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

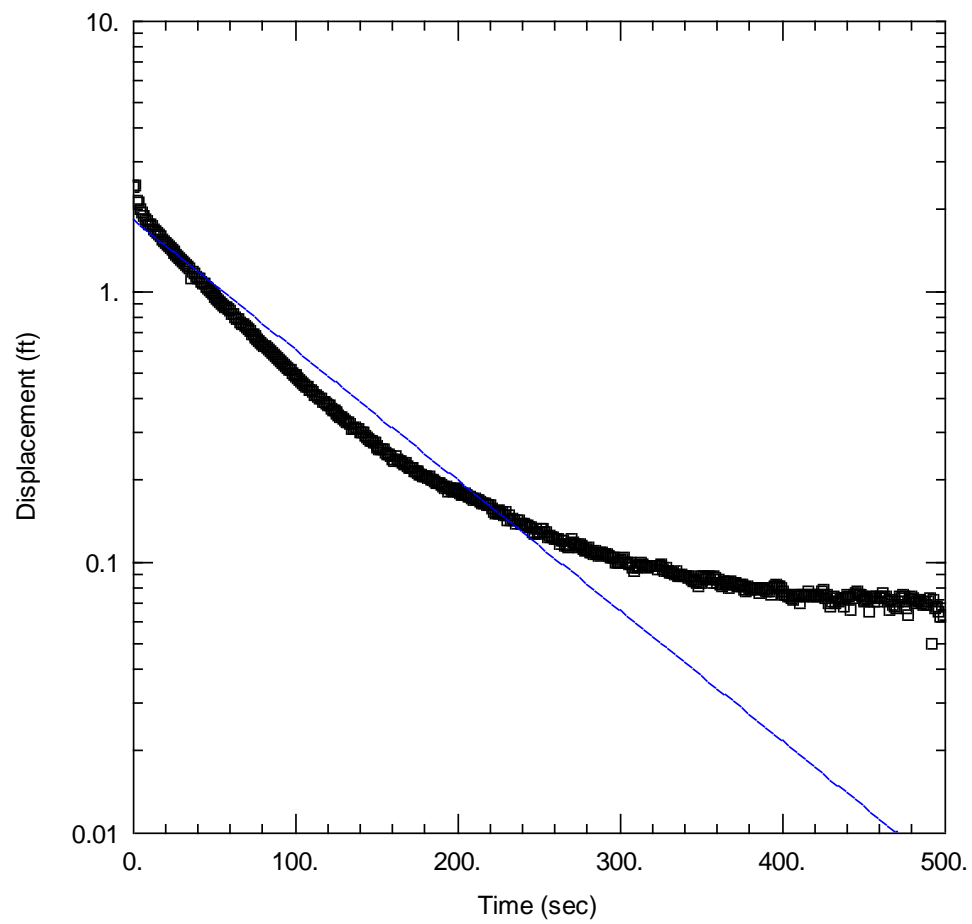
Solution

Bouwer-Rice

Parameters

$K = 6.498E-6$  ft/sec

$y_0 = 1.78$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

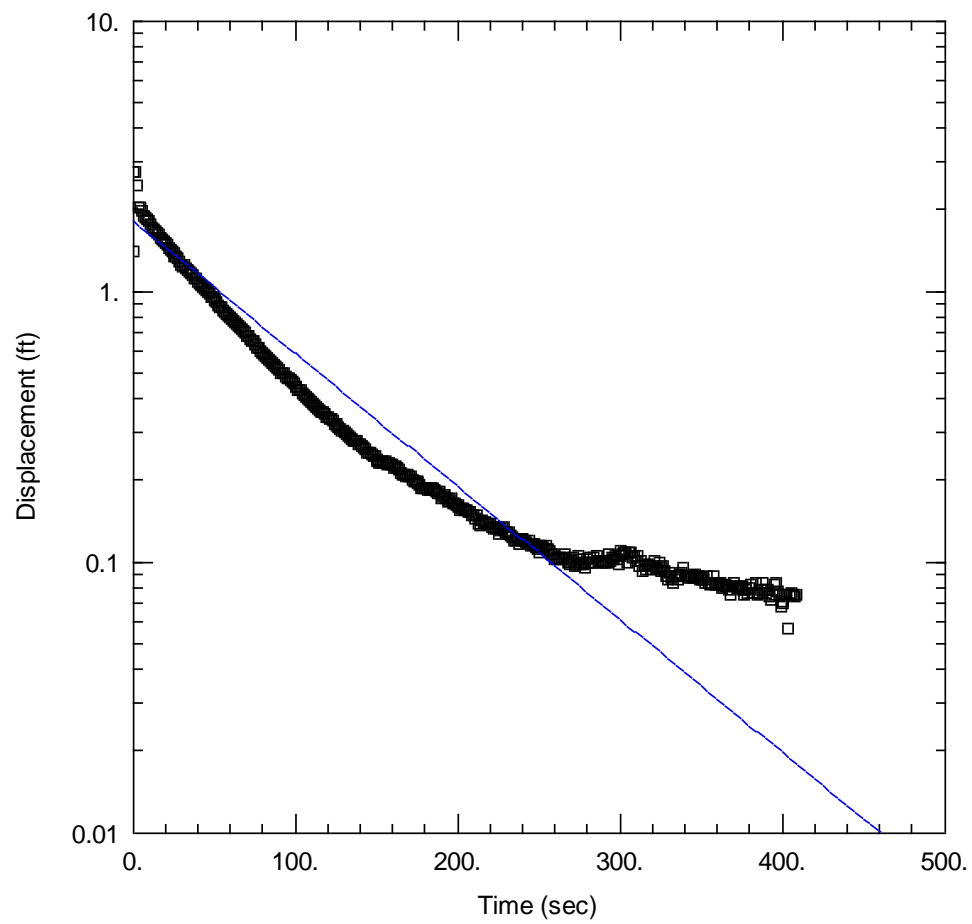
Solution

Hvorslev

Parameters

$K = 9.236\text{E-}6$  ft/sec

$y_0 = 1.841$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

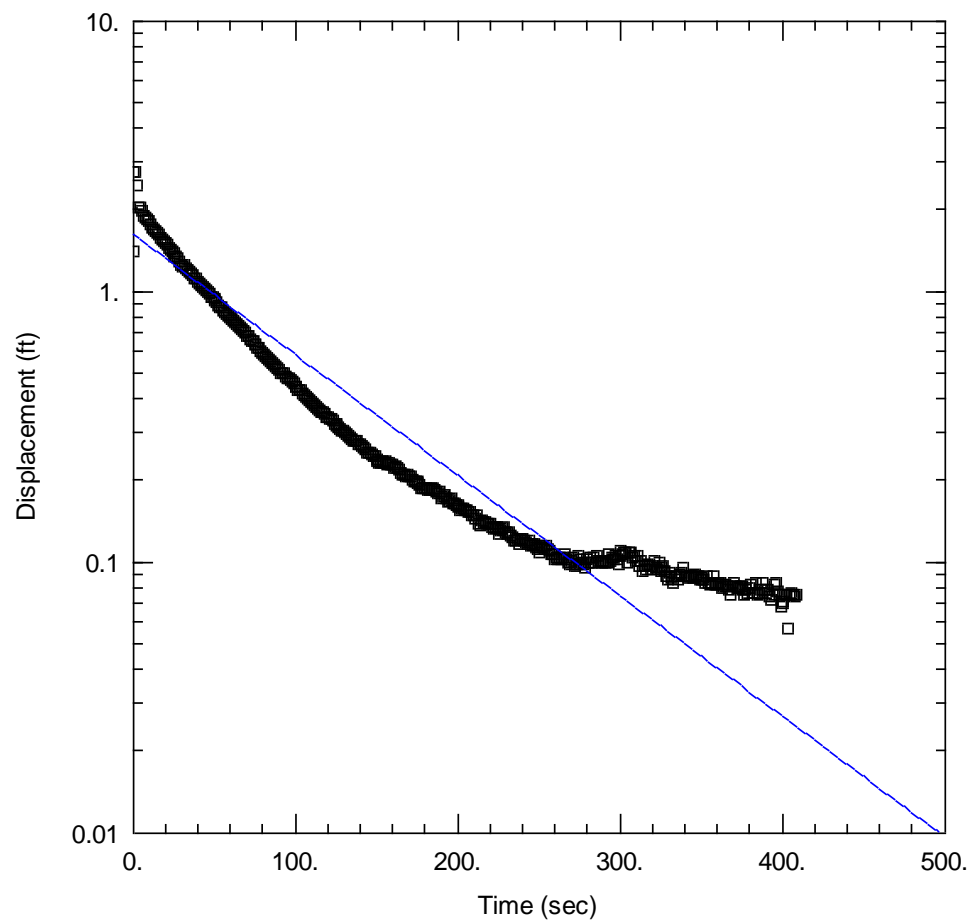
Solution

Bouwer-Rice

Parameters

$K = 6.519\text{E-}6$  ft/sec

$y_0 = 1.821$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

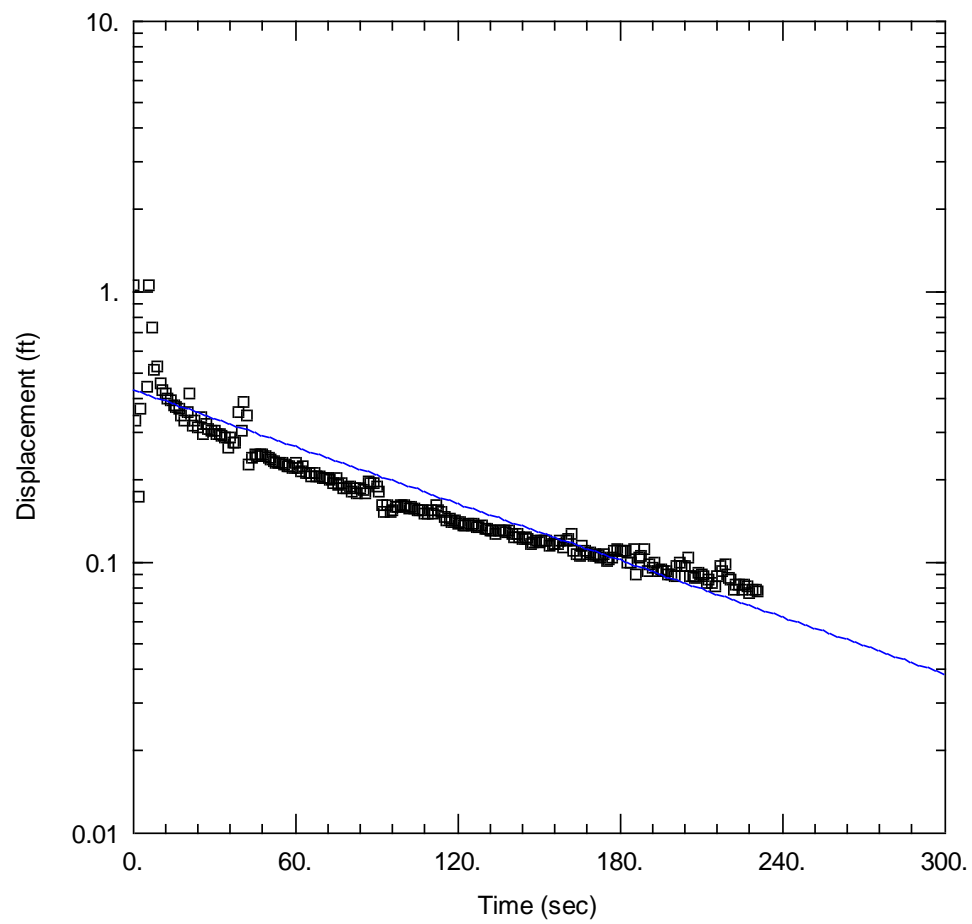
Solution

Hvorslev

Parameters

$K = 8.537\text{E-}6$  ft/sec

$y_0 = 1.625$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

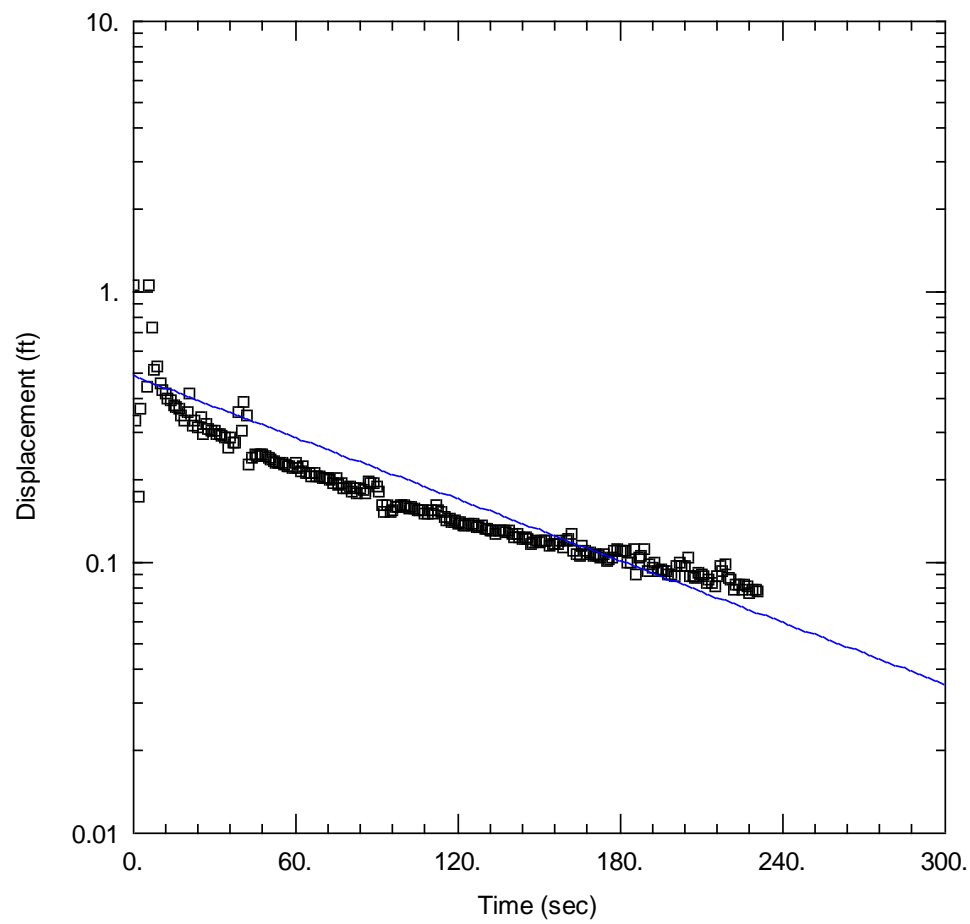
Solution

Bouwer-Rice

Parameters

$K = 6.359\text{E-}6 \text{ ft/sec}$

$y_0 = 0.4324 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

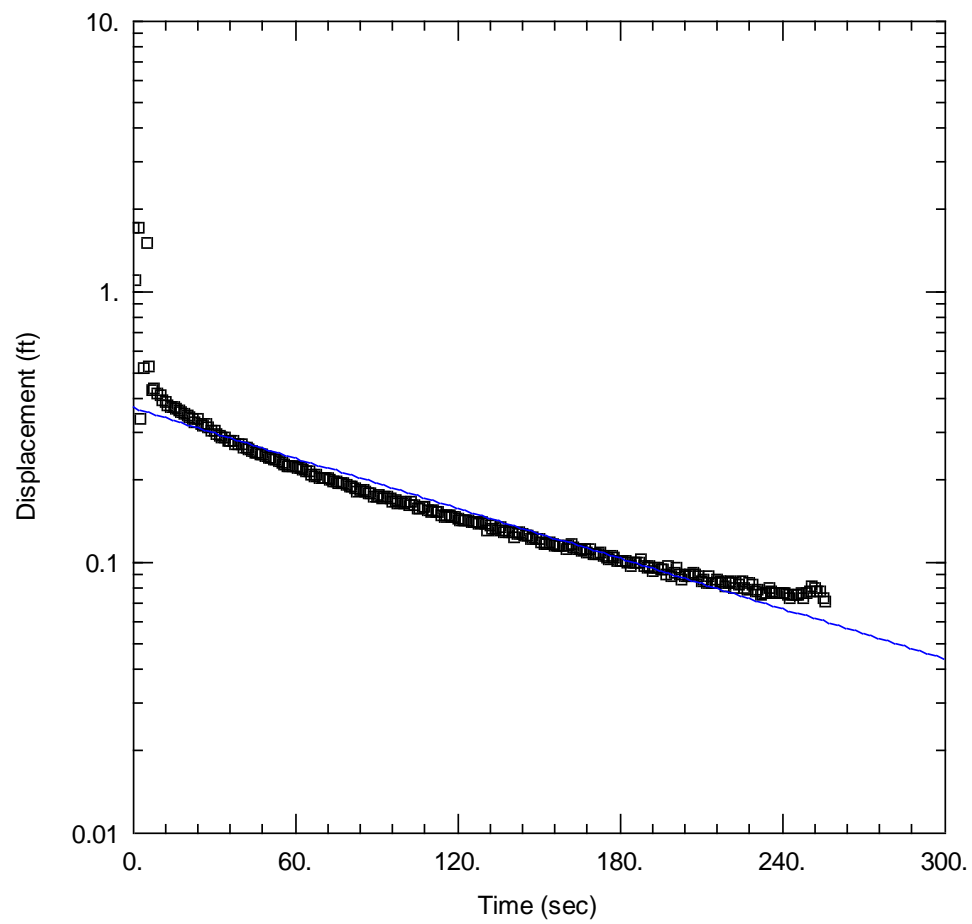
Solution

Hvorslev

Parameters

$K = 1.006E-5$  ft/sec

$y_0 = 0.4882$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

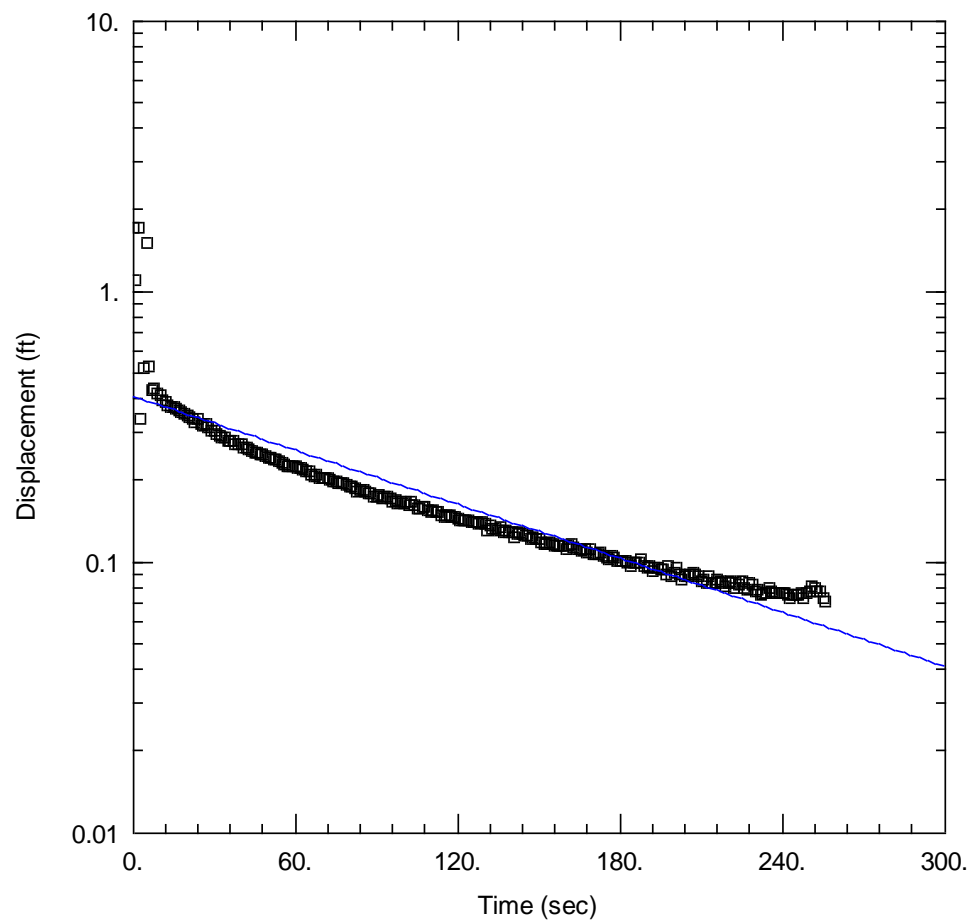
Solution

Bouwer-Rice

Parameters

$K = 5.617\text{E-}6$  ft/sec

$y_0 = 0.3709$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

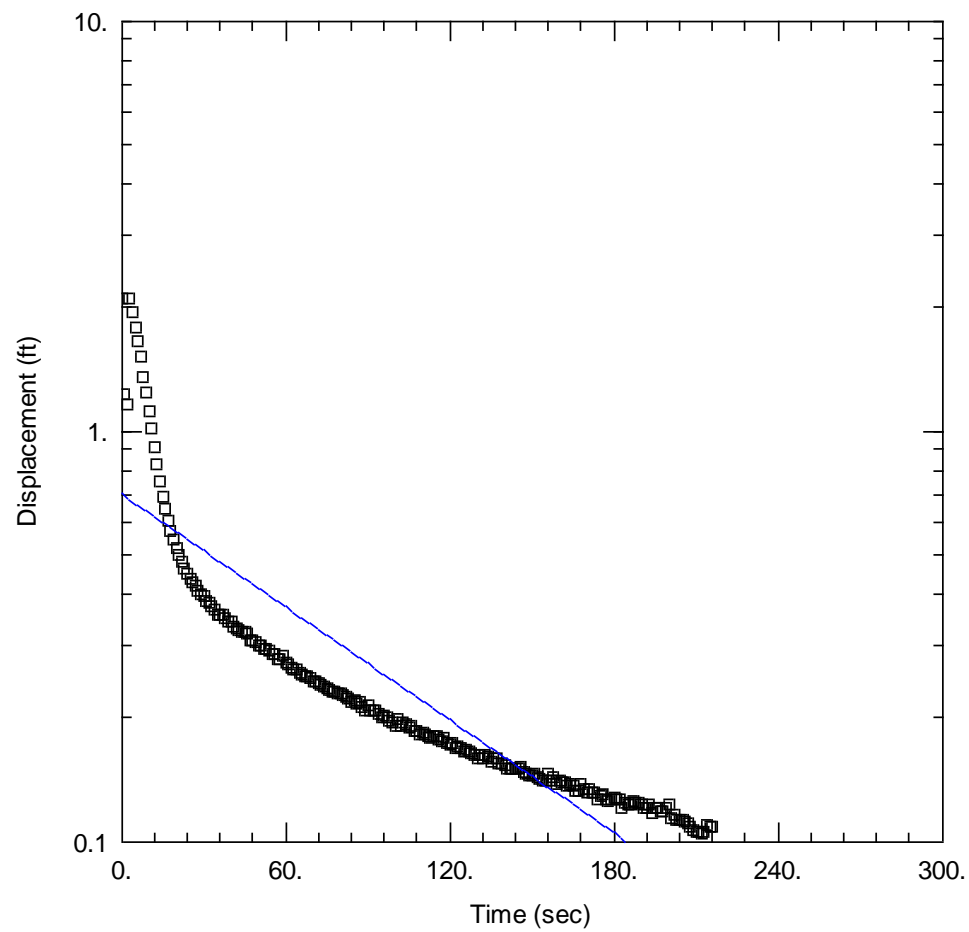
Solution

Hvorslev

Parameters

$K = 8.815\text{E-}6$  ft/sec

$y_0 = 0.4097$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

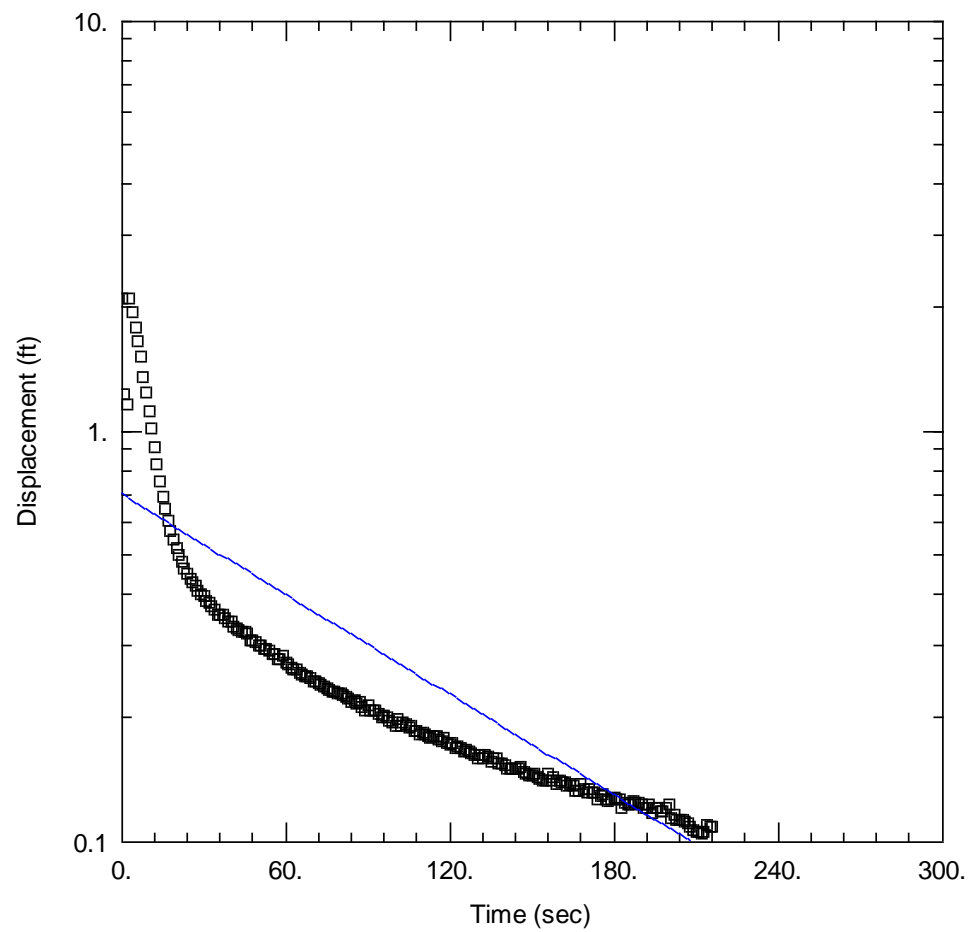
Solution

Bouwer-Rice

Parameters

$K = 8.331\text{E-}6$  ft/sec

$y_0 = 0.702$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

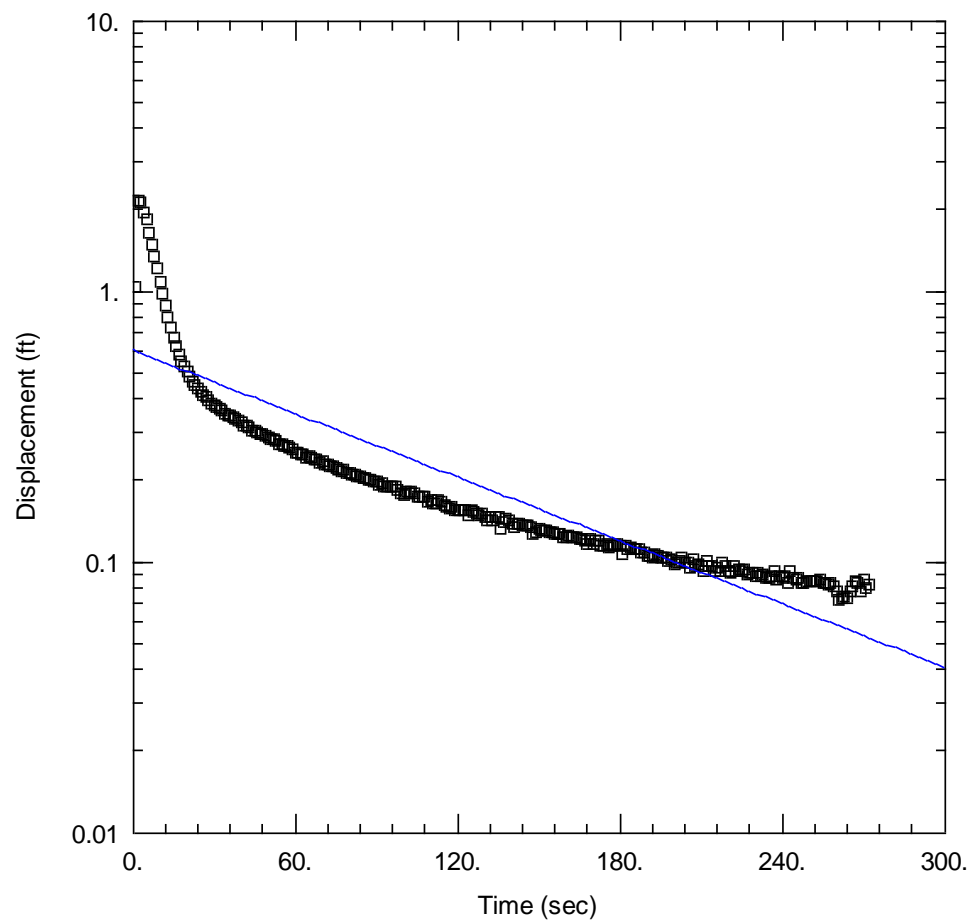
Solution

Hvorslev

Parameters

$K = 1.077\text{E-}5$  ft/sec

$y_0 = 0.7018$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

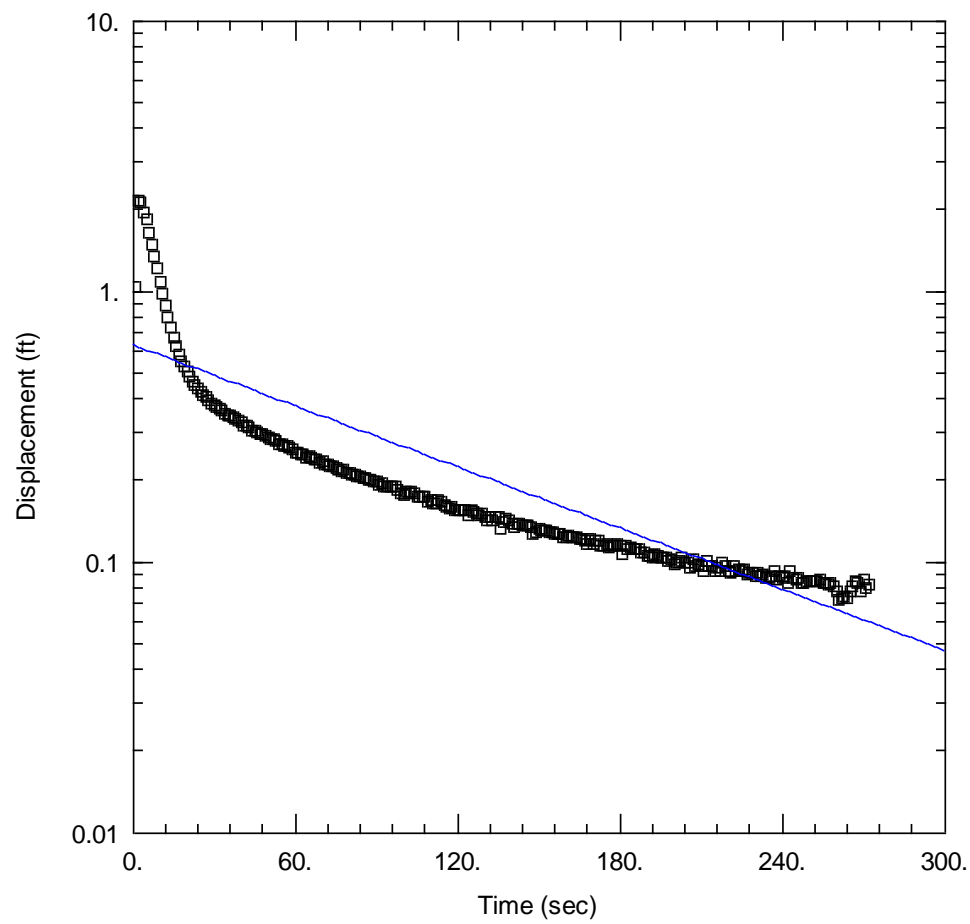
Solution

Bouwer-Rice

Parameters

$K = 7.097\text{E-}6$  ft/sec

$y_0 = 0.6054$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

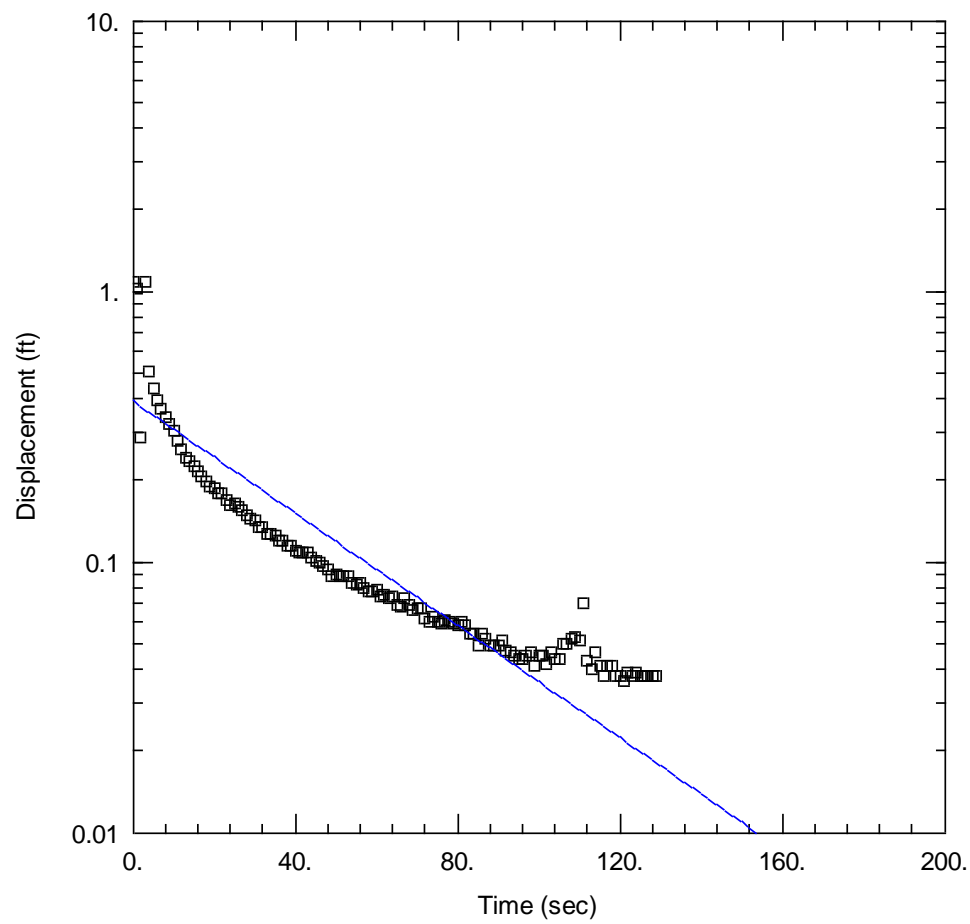
Solution

Hvorslev

Parameters

$K = 9.981\text{E-}6$  ft/sec

$y_0 = 0.6357$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

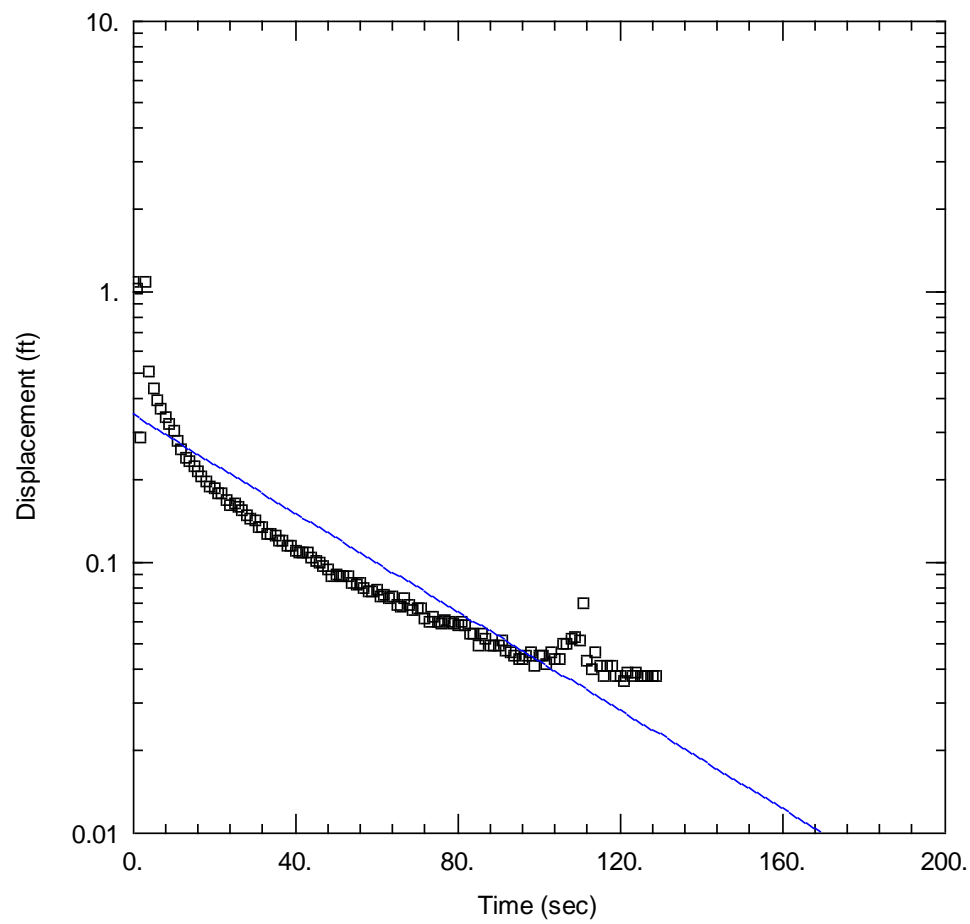
Solution

Bouwer-Rice

Parameters

$K = 2.019\text{E-}5$  ft/sec

$y_0 = 0.3937$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

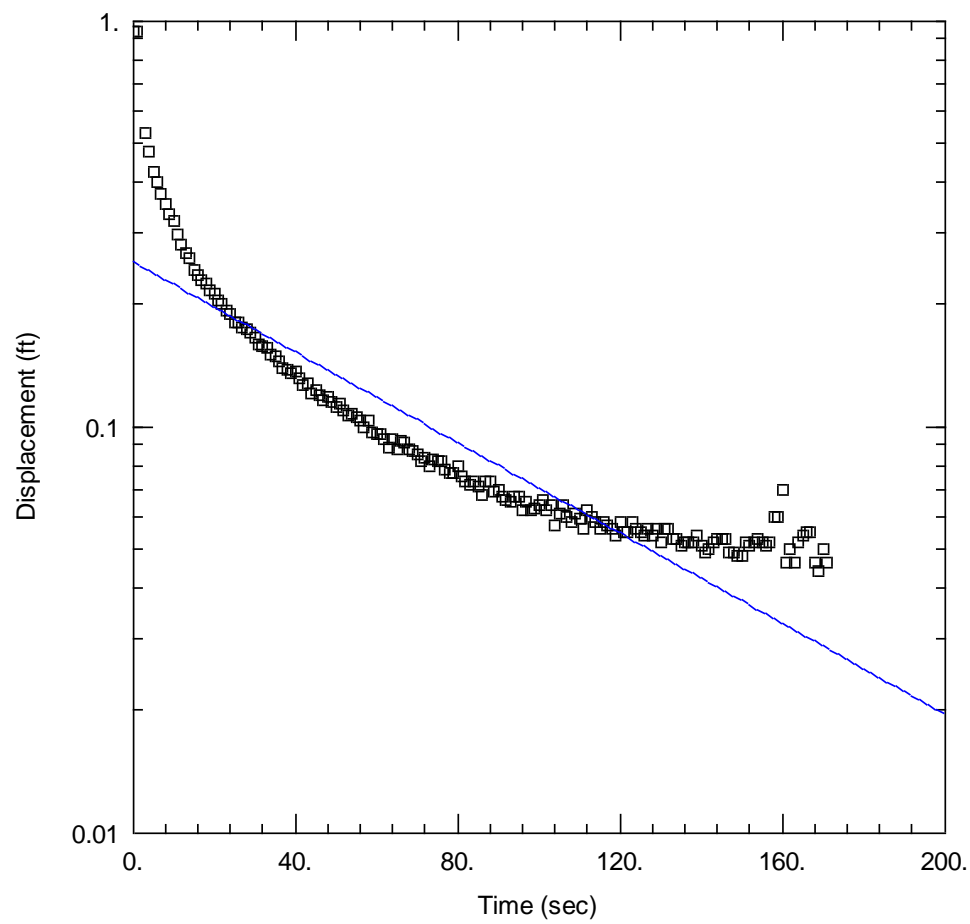
Solution

Hvorslev

Parameters

$K = 2.586E-5$  ft/sec

$y_0 = 0.3499$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

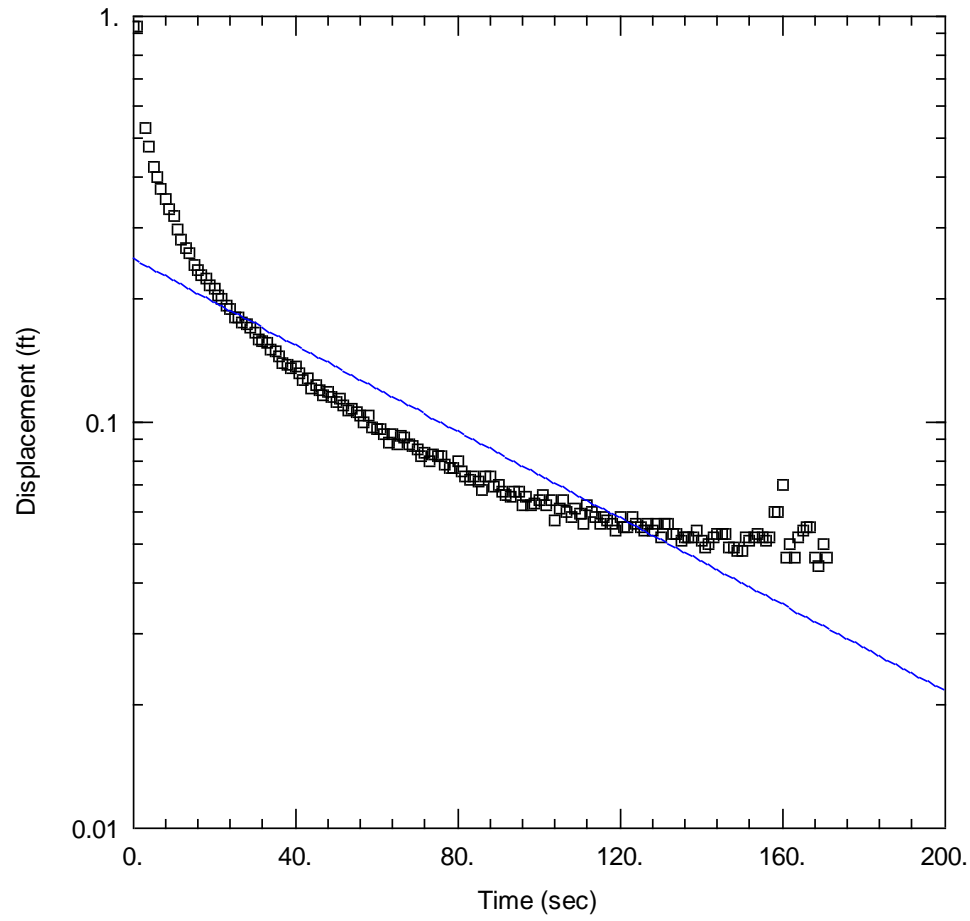
Solution

Bouwer-Rice

Parameters

$K = 1.084E-5$  ft/sec

$y_0 = 0.255$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

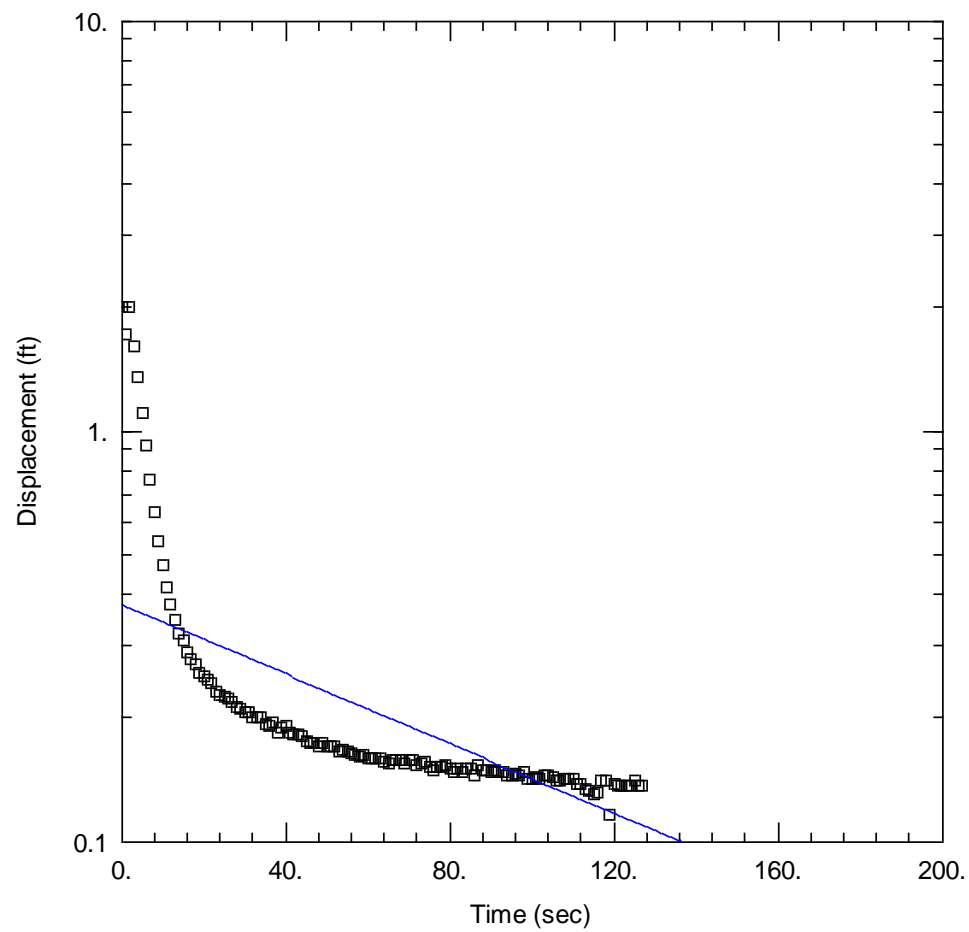
Solution

Hvorslev

Parameters

$K = 1.515\text{E-}5$  ft/sec

$y_0 = 0.2521$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

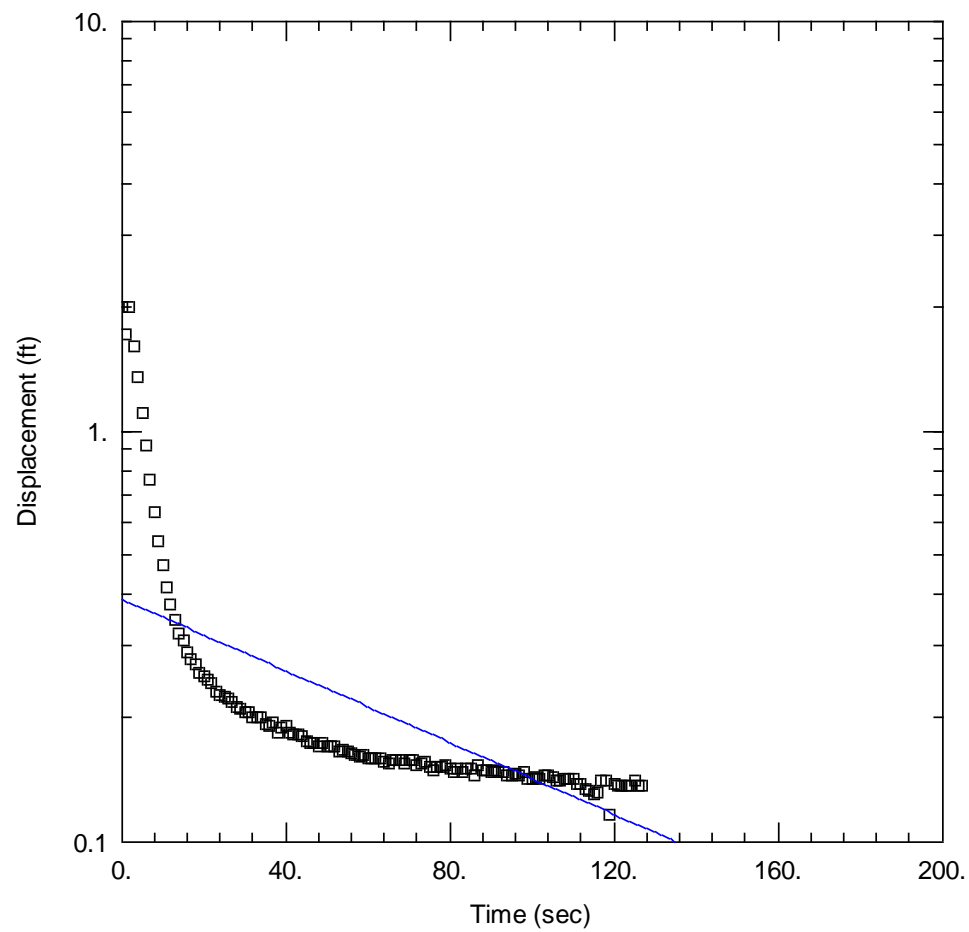
Solution

Bouwer-Rice

Parameters

$K = 8.277\text{E-}6$  ft/sec

$y_0 = 0.3788$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

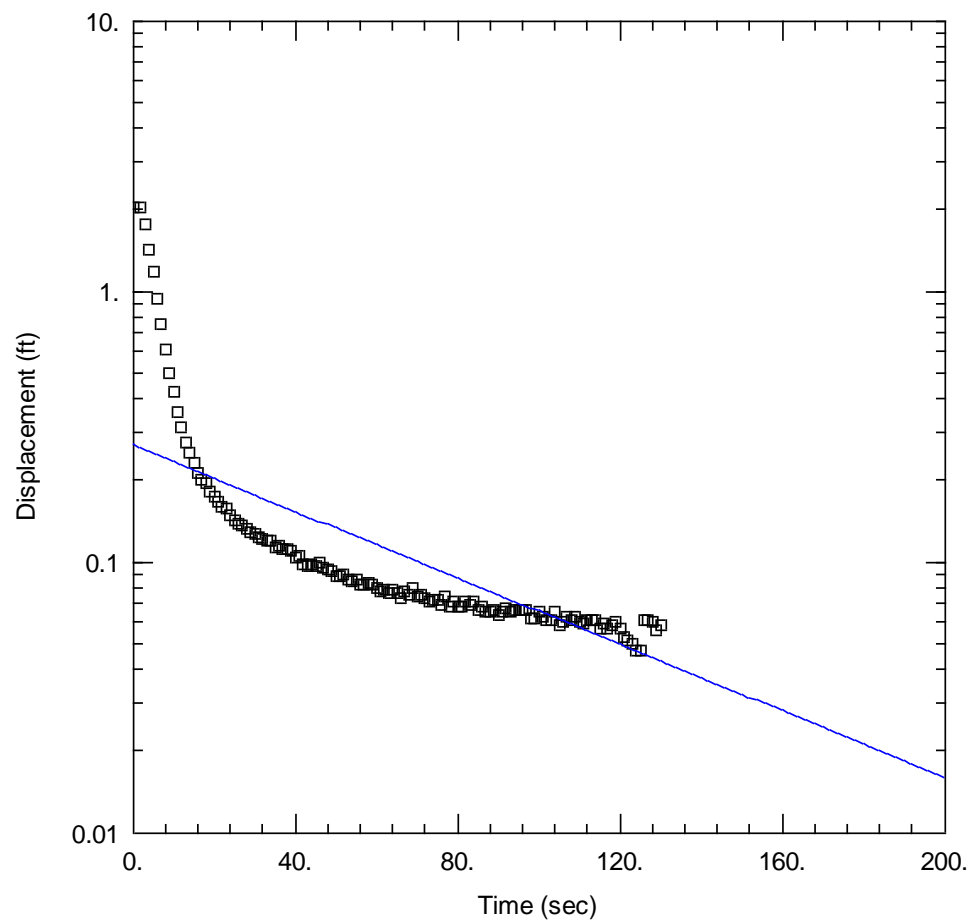
Solution

Hvorslev

Parameters

$K = 1.245E-5$  ft/sec

$y_0 = 0.39$  ft



Obs. Wells

□ New Well

Aquifer Model

Unconfined

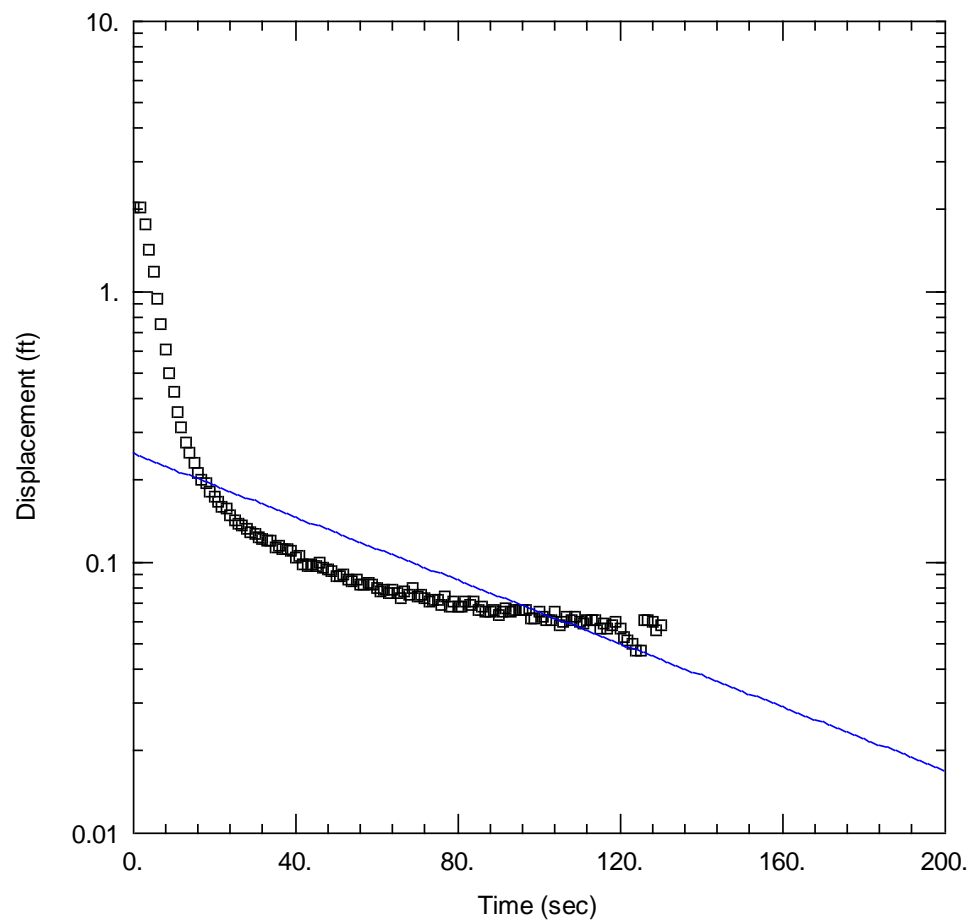
Solution

Bouwer-Rice

Parameters

$K = 1.194\text{E-}5 \text{ ft/sec}$

$y_0 = 0.2704 \text{ ft}$



Obs. Wells

□ New Well

Aquifer Model

Unconfined

Solution

Hvorslev

Parameters

$K = 1.665\text{E-}5 \text{ ft/sec}$

$y_0 = 0.2516 \text{ ft}$

## Appendix G

### Laboratory Analytical Data

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TABLE G-1

Raw Surface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08
Sample ID	CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913	CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS01-1008	CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108
Sample Date	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08
Chemical Name												
Semivolatile Organic Compounds (µg/kg)												
1,1-Biphenyl	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
2,4-Dinitrotoluene	220 U	270 U	270 U	1,400	390 U	400 J	6,300 L	140 J	380 U	380 U	460 U	99 U
2,6-Dinitrotoluene	220 U	270 U	270 U	220 U	390 U	220 U	410 U	380 U	380 U	380 U	460 U	99 U
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2-Chlorophenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2-Methylphenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
2-Nitroaniline	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
2-Nitrophenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
3-Nitroaniline	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
4-Chloroaniline	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
4-Methylphenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
4-Nitroaniline	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
4-Nitrophenol	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 R	1,100 R
Acenaphthene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Acenaphthylene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Acetophenone	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Anthracene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Atrazine	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Benzaldehyde	NA	NA	NA	NA	NA	NA	320 J	380 U	380 U	380 U	460 U	430 U
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	110 J	380 U	380 U	380 U	460 U	430 U
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Caprolactam	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Carbazole	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Chrysene	NA	NA	NA	NA	NA	NA	150 J	380 U	380 U	380 U	460 U	430 U
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Dibenzofuran	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Diethylphthalate	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Fluoranthene	NA	NA	NA	NA	NA	NA	300 J	380 U	380 U	380 U	460 U	430 U
Fluorene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U

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Raw Surface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08
Sample ID	CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913	CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS01-1008	CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108
Sample Date	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08
Chemical Name												
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Hexachloroethane	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	410 UJ	380 U	380 U	380 U	460 U	430 U
Isophorone	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Naphthalene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Nitrobenzene	220 U	270 U	270 U	220 U	390 U	220 U	410 U	380 U	380 U	380 U	460 U	99 U
Pentachlorophenol	NA	NA	NA	NA	NA	NA	1,000 U	950 U	960 U	940 U	1,200 U	1,100 U
Phenanthrene	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Phenol	NA	NA	NA	NA	NA	NA	410 U	380 U	380 U	380 U	460 U	430 U
Pyrene	NA	NA	NA	NA	NA	NA	580 J	380 U	380 U	380 U	460 U	430 U
Explosives (µg/kg)												
1,3,5-Trinitrobenzene	220 U	270 U	270 U	220 U	390 U	400 J	620 K	250	100 U	100 U	100 U	99 U
1,3-Dinitrobenzene	220 U	270 U	270 U	220 U	390 U	220 U	730 J	84 J	100 UJ	100 U	100 U	99 U
2,4,6-Trinitrotoluene	220 U	270 U	270 U	910,000	390 U	720,000	4,500,000	320,000	6,600	170	100 U	99 U
2-Amino-4,6-dinitrotoluene	220 U	270 U	270 U	7,100	390 U	220 U	100 UJ	16,000 J	1,400 J	100 U	100 U	99 U
2-Nitrotoluene	220 U	270 U	270 U	220 U	390 U	220 U	40,000 R	48,000 J	200 UJ	200 U	200 U	200 U
3,5-Dinitroaniline	220 U	270 U	270 U	220 U	390 U	220 U	100 U	100 U	100 U	100 U	100 U	99 UJ
3-Nitrotoluene	220 U	270 U	270 U	220 U	390 U	220 U	40,000 R	200 U	200 U	200 U	200 U	200 U
4-Amino-2,6-dinitrotoluene	220 U	270 U	270 U	4,500	390 U	13,000	20,000 R	17,000	1,400	100 U	100 U	99 U
4-Nitrotoluene	220 U	270 U	270 U	220 U	390 U	220 U	40,000 R	200 U	200 U	200 U	200 U	200 U
HMX	220 U	270 U	270 U	220 U	390 U	220 U	200 U	200 U	200 U	200 U	200 U	200 U
Nitroglycerin	220 U	270 U	270 U	220 U	390 U	220 U	2,500 UJ	2,500 U	2,500 U	2,500 U	5,000 U	5,000 U
Nitroguanidine	NA	NA	NA	NA	NA	NA	10 U	10 U	10 U	130 U	120 U	130 U
PETN	220 U	270 U	270 U	220 U	390 U	220 U	500 U	500 U	500 U	500 U	500 U	500 U
RDX	220 U	270 U	270 U	220 U	390 U	220 U	220	200 U	200 U	200 U	200 U	200 U
Tetryl	220 U	270 U	270 U	220 U	390 U	220 U	640	200 U	200 U	200 U	200 U	200 U
Total Metals (mg/kg)												
Aluminum	3,600	7,600	8,500	6,900	2,700	5,200	10,600	10,400	25,000	9,630	5,230	6,780
Antimony	0.097 B	0.2 B	0.2 B	0.36	0.16 B	0.62	14 UL	4.1 UL	0.21 L	0.1 L	4.5 UL	7.4 UL
Arsenic	1.7	5.2	5.2	3.1	1.6	2.2	8.1 J	3.5 J	11.8 J	3.6 J	2.7 L	3.3 L
Barium	22	18	20	26	9.4	17	31	22.9	45.7	18.8 J	21.2 K	18.3 K
Beryllium	0.37	0.44 J	0.34 J	0.2	0.092 J	0.24	0.34 J	0.36	0.55	0.29 J	0.4	0.26 J
Cadmium	0.033 J	0.033 J	0.031 J	0.061	0.021 J	0.042 J	0.06 J	0.09 J	0.12 J	0.04 J	0.38 U	0.05 B
Calcium	230	270	280	430	330	220	2,260	748	1,980	1,210	304 J	869
Chromium	5.5	11	12	8.5 K	3.6	6.4	16.8 L	12.5 L	34.7 L	16.2 L	6.1	8.6
Chromium (hexavalent)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	3	2.4	2.6	2.5	0.57	1.7	3.6 J	2.2 J	3.4 J	1.9 J	2.6 J	1.3 J
Copper	1.5	2.5	2.7	13 K	1.2	2.5	9.8	6.7	5.5	3.6	2.2 B	4.8 B
Cyanide	0.066 J	0.047 J	0.044 J	0.19 B	0.13	0.47	0.6 U	0.55 U	0.55 U	0.5 U	0.7 U	0.6 U
Iron	3,800	12,000	14,000	8,500	3,900	6,200	37,100 J	9,000 J	21,700 J	9,010 J	4,780	6,270
Lead	16	10	11	34	16	170	580 J	72.9 J	42.8 J	9.9 J	10.8	18.5
Magnesium	270	580	640	680	200	390	896 J	672	1,270	694	406	468 J
Manganese	51	36	36	62	12	31	175	43.3	32.8	25.4	50.5 L	30.9 L
Mercury	0.038 B	0.05	0.045 B	0.089	0.062	0.084	0.13 L	0.05 L	0.12 UL	0.11 UL	0.15 UL	0.06 L
Nickel	3	4	4.3	3.8 K	1.6	3.8	10.1	6.6	10	4.8	3.7	4.1 J
Potassium	190	590	680	350	180	310	719	620	1,520	875	254 J	438 J
Selenium	0.14 B	0.2	0.19	0.2	0.24 B	0.32	2 J	0.38 J	0.91 J	3.8 U	2.6 U	4.3 U

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AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08
Sample ID	CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913	CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS01-1008	CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108
Sample Date	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08
Chemical Name												
Silver	0.026 J	0.021 J	0.022 J	0.026 J	0.022 J	0.055	2.3 U	0.69 U	0.95 U	1.1 U	0.75 U	1.2 U
Sodium	7.2 B	12 B	12 B	15 B	13 B	10 B	68 J	29.5 J	58.7 J	28.6 J	19 B	36.3 B
Thallium	0.063	0.094	0.1	0.083	0.058	0.09	5.7 U	1.7 U	0.18 J	2.7 U	1.9 U	3.1 U
Vanadium	7.6	20	23	18	12	14	26.6	19.6	50	22.1	10.3	18.1
Zinc	15 B	14	17	29	7.1	17	96.7	54.9	176	17	12.2 K	18.6 K
Wet Chemistry												
pH (ph)	5.4	5.1	NA	4.6	4.1	4.4	4.6	6.8	7.1	7.1	5.4	5
Total organic carbon (TOC) (mg/kg)	8,000	12,000	NA	17,000	65,000	20,000	120,000 J	7,300 J	6,200 J	27,000 J	22,000	49,000
Grain Size (pct)												
Coarse Sand (%)	0.3	3.9	NA	2.6	0.9	1.4	NA	NA	NA	NA	NA	NA
Fine Sand (%)	51.4	43.4	NA	50	56.1	54.5	NA	NA	NA	NA	NA	NA
Fines (%)	15.2	8.7	NA	16.3	22.3	19.4	NA	NA	NA	NA	NA	NA
Gravel (%)	0.1	0.3	NA	0.9	1.1	0.4	NA	NA	NA	NA	NA	NA
Medium Sand (%)	33	43.7	NA	30.2	19.6	24.3	NA	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)												
GS07 Sieve 1" (25.0 mm)	100	100	NA	100	100	100	NA	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	100	100	NA	100	100	100	NA	NA	NA	NA	NA	NA
GS10 Sieve 0.375" (9.5 mm)	100	100	NA	100	100	100	NA	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	99.9	99.7	NA	99.1	98.9	99.6	NA	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	99.6	95.8	NA	96.5	98	98.2	NA	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	94.8	80.1	NA	87.7	94.3	92.7	NA	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	66.6	52.1	NA	66.3	78.4	73.9	NA	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	38.4	30.4	NA	42.8	55.6	50.7	NA	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	29.7	22.1	NA	32.8	42.8	38.8	NA	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	26.4	18.8	NA	28.9	37.5	34.2	NA	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	15.2	8.7	NA	16.3	22.3	19.4	NA	NA	NA	NA	NA	NA

Notes:

- Shading indicates detections
- NA - Not analyzed
- B - Analyte not detected above the level reported in blanks
- J - Analyte present, value may or may not be accurate or precise
- K - Analyte present, value may be biased high, actual value may be lower
- L - Analyte present, value may be biased low, actual value may be higher
- R - Rejected Result
- U - The material was analyzed for, but not detected
- UJ - Analyte not detected, quantitation limit may be inaccurate
- UL - Analyte not detected, quantitation limit is probably higher
- mg/kg - Milligrams per kilogram
- pct - Percent
- PCT/P - Percent Pass
- ph - pH units
- µg/kg - Micrograms per kilogram

TABLE G-1

Raw Surface Soil Analytical Data -

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AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO13	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SS13-1108	CAA06-SS26-0913	CAA06-SS26P-0913	CAA06-SO26-000H-0913	CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913	CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS39-0913
Sample Date	11/06/08	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name												
Semivolatile Organic Compounds (µg/kg)												
1,1-Biphenyl	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	290	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2,6-Dinitrotoluene	370 U	NA	NA	310 J	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2-Chloronaphthalene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	940 R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Atrazine	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzaldehyde	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Caprolactam	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	370 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO13	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SS13-1108	CAA06-SS26-0913	CAA06-SS26P-0913	CAA06-SO26-000H-0913	CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913	CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS39-0913
Sample Date	11/06/08	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name												
Hexachlorobenzene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	370 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Pentachlorophenol	940 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	370 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)												
1,3,5-Trinitrobenzene	1,100	NA	NA	20,000	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
1,3-Dinitrobenzene	290	NA	NA	2,500	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2,4,6-Trinitrotoluene	51,000	NA	NA	14,000,000	NA	230 U	220 U	770	1,900	220 U	220 U	220 U
2-Amino-4,6-dinitrotoluene	15,000	NA	NA	270 U	NA	230 U	220 U	870	1,200	220 U	220 U	220 U
2-Nitrotoluene	200 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
3,5-Dinitroaniline	890	NA	NA	1,600	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
3-Nitrotoluene	200 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	14,000	NA	NA	270 U	NA	230 U	220 U	710	980	220 U	220 U	220 U
4-Nitrotoluene	200 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
HMX	200 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Nitroglycerin	5,000 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Nitroguanidine	120 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PETN	500 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
RDX	200 U	NA	NA	380 J	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Tetryl	200 U	NA	NA	270 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Total Metals (mg/kg)												
Aluminum	11,400	NA	NA	7,600	NA	12,000	7,600	6,800	4,400	4,200	4,900	3,700
Antimony	4 UL	NA	NA	0.31	NA	0.2	0.23	0.16	0.1	0.089 J	0.12	0.15 B
Arsenic	5 L	NA	NA	6.1	NA	6	5.4	2.7	1.2	1.1	1.6	1.4
Barium	25.2 K	NA	NA	32	NA	27	13	15	15	16	20	14
Beryllium	0.39	NA	NA	0.35	NA	0.58	0.4	0.19	0.19	0.28	0.37	0.24
Cadmium	0.02 B	NA	NA	0.29	NA	0.022 J	0.031 J	0.017 J	0.02 J	0.032 J	0.046 J	0.028 J
Calcium	415	NA	NA	4,000	NA	170	140	61	170	210	510	180
Chromium	13.9	20	17	10	13	16	12	8.5	4.4	4.3	5.3	3.9
Chromium (hexavalent)	NA	0.27 U	0.3 U	NA	0.23 UL	NA	NA	NA	NA	NA	NA	NA
Cobalt	2.4 J	NA	NA	2.2	NA	2.5	1.9	1.6	1.1	1.2	1.8	1
Copper	4.2 B	NA	NA	9.5	NA	4.1	2.8	4.8	1.4	1.2	1.5	1.3
Cyanide	1.3	NA	NA	0.57	NA	0.042 B	0.087 J	0.089 J	0.08 J	0.055 B	0.11 B	0.08 J
Iron	10,300	NA	NA	38,000	NA	14,000	14,000	8,800	5,300	4,000	5,300	4,000
Lead	101	NA	NA	1,100	NA	12	19	31	110	59	21	18
Magnesium	747	NA	NA	740	NA	690	560	430	380	340	440	280
Manganese	41.1 L	NA	NA	92	NA	39	31	29	16	22	35	17
Mercury	0.08 L	NA	NA	0.13	NA	0.075	0.046 J	0.066	0.06	0.057	0.048 J	0.038 B
Nickel	7	NA	NA	6.3	NA	4.9	3.8	3.4	2.6	2.8	3.6	2.4
Potassium	589 J	NA	NA	650	NA	490	670	310	230	210	240	210
Selenium	0.38 J	NA	NA	0.33	NA	0.28	0.21	0.11	0.05 J	0.1	0.15	0.14 B

TABLE G-1

Raw Surface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO13	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SS13-1108	CAA06-SS26-0913	CAA06-SS26P-0913	CAA06-SO26-000H-0913	CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913	CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS39-0913
Sample Date	11/06/08	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name												
Silver	0.67 U	NA	NA	0.052	NA	0.017 J	0.025 J	0.021 J	0.03 J	0.019 J	0.026 J	0.028 J
Sodium	27.2 B	NA	NA	38 J	NA	15 J	14 J	14 J	9.7 J	8.7 J	11 J	9.2 B
Thallium	0.09 B	NA	NA	0.095	NA	0.14	0.086	0.1	0.09	0.081	0.094	0.074
Vanadium	22.5	NA	NA	25	NA	27	24	17	12	8.4	12	9.7
Zinc	25.9 K	NA	NA	120	NA	19 B	16	17	12	18 B	17	8.3
Wet Chemistry												
pH (ph)	5	NA	NA	5.7	NA	4.9	4.8	4.4	4.6	5	5.2	4.8
Total organic carbon (TOC) (mg/kg)	30,000	NA	NA	120,000	NA	15,000	22,000	10,000	####	11,000	#####	19,000
Grain Size (pct)												
Coarse Sand (%)	NA	NA	NA	8.2	NA	9.7	2	1.8	0.3	0.3	1.2	1
Fine Sand (%)	NA	NA	NA	42.3	NA	38.7	46.7	49.6	53	56.1	53.9	56.1
Fines (%)	NA	NA	NA	8.2	NA	11.3	8.4	19.9	26.7	25.7	19.6	21.8
Gravel (%)	NA	NA	NA	3.2	NA	0.7	0.5	1.7	0.1	0.1	2.6	0.4
Medium Sand (%)	NA	NA	NA	38.1	NA	39.6	42.4	27	19.9	17.8	22.7	20.7
GRAINSIZE (PCT/P)												
GS07 Sieve 1" (25.0 mm)	NA	NA	NA	100	NA	100	100	100	100	100	100	100
GS08 Sieve 0.75" (19.0 mm)	NA	NA	NA	100	NA	100	100	100	100	100	100	100
GS10 Sieve 0.375" (9.5 mm)	NA	NA	NA	100	NA	100	100	100	100	100	100	100
Sieve No. 004 (4.75 mm)	NA	NA	NA	96.8	NA	99.3	99.5	98.3	99.9	99.9	97.4	99.6
Sieve No. 010 (2.00 mm)	NA	NA	NA	88.6	NA	89.6	97.5	96.5	99.6	99.6	96.2	98.6
Sieve No. 020 (850 um)	NA	NA	NA	73	NA	71.5	85.9	89.4	97	97	91.4	95.1
Sieve No. 040 (425 um)	NA	NA	NA	50.5	NA	50	55.1	69.5	79.7	81.8	73.5	77.9
Sieve No. 060 (250 um)	NA	NA	NA	30	NA	31.9	30.3	47.5	56.9	59.3	51.4	54.8
Sieve No. 080 (180 um)	NA	NA	NA	21.3	NA	23.5	22.3	37	45.5	46	39.3	42.1
Sieve No. 100 (150 um)	NA	NA	NA	17.9	NA	20.2	19.1	32.8	40.9	40.9	34.6	37.2
Sieve No. 200 (75 um)	NA	NA	NA	8.2	NA	11.3	8.4	19.9	26.7	25.7	19.6	21.8

Notes:

- Shading indicates detections
- NA - Not analyzed
- B - Analyte not detected above the level reported in blanks
- J - Analyte present, value may or may not be accurate or precise
- K - Analyte present, value may be biased high, actual value may be lower
- L - Analyte present, value may be biased low, actual value may be higher
- R - Rejected Result
- U - The material was analyzed for, but not detected
- UJ - Analyte not detected, quantitation limit may be inaccurate
- UL - Analyte not detected, quantitation limit is probably higher
- mg/kg - Milligrams per kilogram
- pct - Percent
- PCT/P - Percent Pass
- ph - pH units
- µg/kg - Micrograms per kilogram

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13
Sample ID	CAA06-SB34-0H02-0913	CAA06-SB35-0H02-0913	CAA06-SB35P-0H02-0913	CAA06-SB36-0H02-0913	CAA06-SB37-0H02-0913	CAA06-SB38-0H02-0913	CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108	CAA06-SB13-1108
Sample Date	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08
Chemical Name													
Semivolatile Organic Compounds (µg/kg)													
1,1-Biphenyl	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 U	930 U	930 U
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 U	930 U	930 U
2,4-Dinitrotoluene	210 U	230 U	260 U	700	240 U	260 U	1,700	450 U	380 U	360 U	390 U	370 U	780
2,6-Dinitrotoluene	210 U	230 U	260 U	250 U	240 U	260 U	99 U	450 U	380 U	360 U	390 U	370 U	370 U
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2-Chlorophenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2-Methylphenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
2-Nitroaniline	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 U	930 U	930 U
2-Nitrophenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
3-Nitroaniline	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 U	930 U	930 U
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	950 UJ	1,100 U	970 U	910 U	990 U	930 U	930 U
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
4-Chloroaniline	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
4-Methylphenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
4-Nitroaniline	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 U	930 U	930 U
4-Nitrophenol	NA	NA	NA	NA	NA	NA	950 U	1,100 U	970 U	910 U	990 R	930 R	930 R
Acenaphthene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Acenaphthylene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Acetophenone	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Anthracene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Atrazine	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Benzaldehyde	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Caprolactam	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Carbazole	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 UJ
Chrysene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Dibenzofuran	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Diethylphthalate	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Fluoranthene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Fluorene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Hexachloroethane	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Isophorone	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Naphthalene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Nitrobenzene	210 U	230 U	260 U	250 U	240 U	260 U	99 U	450 U	380 U	360 U	390 U	370 U	370 U

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13
Sample ID	CAA06-SB34-0H02-0913	CAA06-SB35-0H02-0913	CAA06-SB35P-0H02-0913	CAA06-SB36-0H02-0913	CAA06-SB37-0H02-0913	CAA06-SB38-0H02-0913	CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108	CAA06-SB13-1108
Sample Date	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08
Chemical Name													
Pentachlorophenol	NA	NA	NA	NA	NA	NA	950 UJ	1,100 U	970 U	910 U	990 U	930 U	930 U
Phenanthrene	NA	NA	NA	NA	NA	NA	380 UJ	450 U	380 U	360 U	390 U	370 U	370 U
Phenol	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Pyrene	NA	NA	NA	NA	NA	NA	380 U	450 U	380 U	360 U	390 U	370 U	370 U
Explosives (µg/kg)													
1,3,5-Trinitrobenzene	210 U	230 U	260 U	250 U	240 U	260 U	99 U	100 U	100 U	100 U	100 U	100 U	100 U
1,3-Dinitrobenzene	210 U	230 U	260 U	250 U	240 U	260 U	1,600 J	100 UJ	28 J	100 U	100 U	100 U	290
2,4,6-Trinitrotoluene	210 U	230 U	260 U	490,000	240 U	80,000	2,700,000	6,700	1,400	100 U	100 U	100 U	660,000
2-Amino-4,6-dinitrotoluene	210 U	230 U	260 U	3,200	240 U	6,200	99 UJ	610 J	650 J	100 U	100 U	100 U	15,000
2-Nitrotoluene	210 U	230 U	260 U	250 U	240 U	260 U	200 UJ	200 UJ	200 UJ	200 U	200 U	200 U	200 U
3,5-Dinitroaniline	210 U	230 U	260 U	250 U	240 U	260 U	99 U	100 U	100 U	100 U	100 U	100 UJ	550
3-Nitrotoluene	210 U	230 U	260 U	250 U	240 U	260 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
4-Amino-2,6-dinitrotoluene	210 U	230 U	260 U	2,300	240 U	7,900	99 U	100 U	340	100 U	100 U	100 U	30,000
4-Nitrotoluene	210 U	230 U	260 U	3,200	240 U	260 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
HMX	210 U	230 U	260 U	250 U	240 U	260 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
Nitroglycerin	210 U	230 U	260 U	250 U	240 U	260 U	2,500 U	2,500 U	2,500 U	2,500 U	5,000 U	5,000 U	5,000 U
Nitroguanidine	NA	NA	NA	NA	NA	NA	10 U	10 U	10 U	130 U	130 U	130 U	130 U
PETN	210 U	230 U	260 U	250 U	240 U	260 U	490 U	500 U	500 U	500 U	500 U	500 U	500 U
RDX	210 U	230 U	260 U	250 U	240 U	260 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
Tetryl	210 U	230 U	260 U	250 U	240 U	260 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
Total Metals (mg/kg)													
Aluminum	3,000	11,000	11,000	15,000	9,500	7,200	10,400	16,200	23,600	10,400	4,200	9,950	13,400
Antimony	0.07 B	0.15 B	0.14 B	0.21 B	0.18 B	0.72	10 UL	6.8 UL	11 UL	6 UL	4.6 UL	5.8 UL	4.2 UL
Arsenic	1.4	3.8	3.8	5.6 L	5.4	2.7	20.9 J	9.6 J	14.4 J	6.8 J	2 L	4 L	5.4 L
Barium	19	32	30	29	17	21	15.3 J	24.5	35.9	13.5 J	16.4 K	28.8 K	25.4 K
Beryllium	0.36	0.48	0.55	0.63	0.25	0.26	0.73	0.4 J	0.67	0.48 J	0.37 J	0.34 J	0.42
Cadmium	0.022 J	0.022 J	0.027 J	0.019 J	0.015 J	0.025 J	0.02 J	0.57 U	0.9 U	0.11 J	0.38 U	0.48 U	0.35 U
Calcium	100	1,000	940	69	170	330	578	910	1,340	578	104 J	1,120	482
Chromium (hexavalent)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	4.1	13	11	18	13	8.4	34.4 L	23.6 L	36.3 L	19.7 L	5.2	12.5	16.3
Cobalt	2.7	3.6	3.3	3.2	2	2.2	3.3 J	3.5 J	5 J	2.5 J	2.4 J	1.8 J	2.6 J
Copper	0.79	2.6	2.7	4.1	2.4	1.9	4.3	4.6	8.1	3.9	1.5 B	2.7 B	4.8 B
Cyanide	0.052 U	0.054 U	0.055 U	0.084 L	0.035 J	0.21	0.55 U	0.65 U	0.6 U	0.55 U	0.5 U	0.55 U	0.54 J
Iron	3,900	12,000	12,000	17,000	12,000	8,500	34,700 J	15,400 J	25,700 J	17,800 J	3,460	8,260	11,900
Lead	4	7.8	7.4	13 L	9.6	33	25 J	10.8 J	16.6 J	6.9 J	4.1	8.7	35.4
Magnesium	270	870	860	830	510	490	678 J	933	1,410	776	332 J	591	855
Manganese	32	62	55	69	27	34	108	31	37.4	26.5	31.8 L	36.9 L	39.4 L
Mercury	0.02 B	0.044 B	0.049 J	0.055	0.041 B	0.07	0.11 UL	0.14 UL	0.11 UL	0.1 UL	0.12 UL	0.086 UL	0.05 L
Nickel	2.6	6.1	5.7	6.7	4.2	4.2	7.2	8.3	17.2	5.6	3.3	5.2	7
Potassium	180	470	440	550	410	320	821	984	1,630	1,010	203 J	507 J	687 J
Selenium	0.065 B	0.35	0.33	0.36 L	0.35	0.27 B	1.4 J	0.64 J	1.6 J	0.62 J	2.7 U	0.4 J	0.41 J
Silver	0.014 J	0.02 J	0.023 J	0.026 J	0.02 J	0.011 J	1.7 U	1.1 U	1.8 U	1 U	0.77 U	0.96 U	0.69 U
Sodium	23 U	23 B	22 B	21 B	16 B	13 B	29.5 J	40.9 J	60.6 J	33.8 J	15.2 B	33.2 B	25.8 B
Thallium	0.054	0.14	0.13	0.17	0.12	0.1	4.2 U	2.8 U	4.5 U	0.07 J	1.9 U	0.12 B	0.11 B
Vanadium	6.4	23	21	30	22	16	32.6	33.4	54.2	28.3	6.9	19.1	23.9
Zinc	8.5	20 B	18 B	27	16	16	24	24.7	34.6	19.7	7.6 K	16.2 K	20.8 K
Wet Chemistry													
pH (ph)	5.7	6.4	NA	4.3	4.5	5.2	6	5.7	6.1	6.1	5.8	6.8	5.3
Total organic carbon (TOC) (mg/kg)	1,200	4,500	NA	7,700	12,000	6,800	2,600 J	3,200 J	2,200 J	2,500 J	4,700	12,000	5,600
Grain Size (pct)													
Coarse Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fine Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fines (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gravel (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Medium Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)													
GS07 Sieve 1" (25.0 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01		CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13
Sample ID	CAA06-SB34-0H02-0913		CAA06-SB35-0H02-0913	CAA06-SB35P-0H02-0913	CAA06-SB36-0H02-0913	CAA06-SB37-0H02-0913	CAA06-SB38-0H02-0913	CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108	CAA06-SB13-1108
Sample Date	09/17/13		09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08
Chemical Name														
GS10 Sieve 0.375" (9.5 mm)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Shading indicates detections

- NA - Not analyzed
- B - Analyte not detected above the level reported in blanks
- J - Analyte present, value may or may not be accurate or precise
- K - Analyte present, value may be biased high, actual value may be lower
- L - Analyte present, value may be biased low, actual value may be higher
- R - Rejected Result
- U - The material was analyzed for, but not detected
- UJ - Analyte not detected, quantitation limit may be inaccurate
- UL - Analyte not detected, quantitation limit is probably higher
- mg/kg - Milligrams per kilogram
- pct - Percent
- PCT/P - Percent Pass
- ph - pH units
- µg/kg - Micrograms per kilogram

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913	CAA06-SO26-0H02-0913	CAA06-SB27-0H02-0913	CAA06-SB28-0H02-0913	CAA06-SB29-0H02-0913	CAA06-SB30-0H02-0913	CAA06-SB31-0H02-0913	CAA06-SB32-0H02-0913	CAA06-SB33-0H02-0913	CAA06-SB39-0H02-0913
Sample Date	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name											
Semivolatile Organic Compounds (µg/kg)											
1,1-Biphenyl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	12,000	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2,6-Dinitrotoluene	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Atrazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Caprolactam	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913	CAA06-SO26-0H02-0913	CAA06-SB27-0H02-0913	CAA06-SB28-0H02-0913	CAA06-SB29-0H02-0913	CAA06-SB30-0H02-0913	CAA06-SB31-0H02-0913	CAA06-SB32-0H02-0913	CAA06-SB33-0H02-0913	CAA06-SB39-0H02-0913
Sample Date	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name											
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)											
1,3,5-Trinitrobenzene	NA	NA	12,000	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
1,3-Dinitrobenzene	NA	NA	1,500	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
2,4,6-Trinitrotoluene	NA	NA	9,300,000	NA	230 U	220 U	220 U	1,500	220 U	220 U	220 U
2-Amino-4,6-dinitrotoluene	NA	NA	14,000	NA	230 U	220 U	220 U	4,400	220 U	220 U	220 U
2-Nitrotoluene	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
3,5-Dinitroaniline	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
3-Nitrotoluene	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	NA	NA	12,000	NA	230 U	220 U	220 U	2,600	220 U	220 U	220 U
4-Nitrotoluene	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
HMX	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Nitroglycerin	NA	NA	280 R	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Nitroguanidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PETN	NA	NA	280 UL	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
RDX	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Tetryl	NA	NA	280 U	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U
Total Metals (mg/kg)											
Aluminum	NA	NA	6,700	NA	13,000	9,800	11,000	14,000	8,600	5,000	9,100
Antimony	NA	NA	0.29	NA	0.19	0.22	0.14	0.15	0.11	0.088 J	0.13 B
Arsenic	NA	NA	10	NA	4.2	5.2	3.6	4.1	2.3	1.5	2.4
Barium	NA	NA	21	NA	28	17	24	32	20	23	20
Beryllium	NA	NA	0.44	NA	0.44	0.33	0.53	0.53	0.28	0.36	0.37
Cadmium	NA	NA	0.14	NA	0.016 J	0.029 J	0.033 J	0.034 J	0.025 J	0.023 J	0.013 J
Calcium	NA	NA	1,800	NA	270	110	77	400	240	350	110
Chromium (hexavalent)	0.27 J	0.31 J	NA	0.94	NA	NA	NA	NA	NA	NA	NA
Chromium	21 J	15 J	12	18 K	16	14	13	14	9.3	6.1	9.1
Cobalt	NA	NA	2.9	NA	2.9	2.5	2.5	3.7	2	1.9	2
Copper	NA	NA	6	NA	2.6	3.8	2.5	3	1.5	0.92	1.5
Cyanide	NA	NA	0.42	NA	0.055 U	0.052 B	0.038 B	0.077 J	0.029 B	0.03 B	0.054 U
Iron	NA	NA	31,000	NA	14,000	14,000	13,000	16,000	9,100	4,900	8,600
Lead	NA	NA	470	NA	10	34	11	17	30	11	6.8
Magnesium	NA	NA	610	NA	740	660	690	930	570	440	590
Manganese	NA	NA	130	NA	30	39	27	69	30	31	21
Mercury	NA	NA	0.058	NA	0.085	0.039 J	0.049 J	0.058	0.052	0.034 J	0.041 B
Nickel	NA	NA	4.5	NA	5.2	4.7	5.1	7.8	4.1	3.7	3.9
Potassium	NA	NA	730	NA	520	600	400	500	370	240	370
Selenium	NA	NA	0.18	NA	0.32	0.21	0.26	0.3	0.17	0.2	0.26
Silver	NA	NA	0.025 J	NA	0.015 J	0.029 J	0.018 J	0.021 J	0.015 J	0.015 J	0.018 J
Sodium	NA	NA	25 J	NA	18 J	14 J	13 J	19 J	13 J	9.6 J	12 B
Thallium	NA	NA	0.092	NA	0.15	0.12	0.14	0.16	0.11	0.11	0.12
Vanadium	NA	NA	21	NA	27	23	23	28	19	9.9	18
Zinc	NA	NA	66 B	NA	18	21	24	30	27	14	14
Wet Chemistry											
pH (ph)	NA	NA	5.7	NA	5.1	4.8	4.5	5.1	5.2	5.4	5
Total organic carbon (TOC) (mg/kg)	NA	NA	22,000	NA	4,100	17,000	6,000	5,600	5,900	5,900	4,700
Grain Size (pct)											
Coarse Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fine Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fines (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gravel (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Medium Sand (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRAINSIZE (PCT/P)											
GS07 Sieve 1" (25.0 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GS08 Sieve 0.75" (19.0 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE G-2

Raw Subsurface Soil Analytical Data -

October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-SO26			CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-SO39
Sample ID	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913	CAA06-SO26-0H02-0913	CAA06-SB27-0H02-0913	CAA06-SB28-0H02-0913	CAA06-SB29-0H02-0913	CAA06-SB30-0H02-0913	CAA06-SB31-0H02-0913	CAA06-SB32-0H02-0913	CAA06-SB33-0H02-0913	CAA06-SB39-0H02-0913
Sample Date	09/19/13	09/19/13	09/19/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Chemical Name											
GS10 Sieve 0.375" (9.5 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 004 (4.75 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 010 (2.00 mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 020 (850 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 040 (425 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 060 (250 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 080 (180 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 100 (150 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sieve No. 200 (75 um)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Shading indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

R - Rejected Result

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UL - Analyte not detected, quantitation limit is probably higher

mg/kg - Milligrams per kilogram

pct - Percent

PCT/P - Percent Pass

ph - pH units

µg/kg - Micrograms per kilogram

TABLE G-3

Raw Groundwater Analytical Data - October-November 2008 and September 2013

AOC 6 TNT Subareas Remedial Investigation

Cheatham Annex, Williamsburg, Virginia

Station ID	CAA06-MW01		CAA06-MW02	CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-MW06
Sample ID	CAA06-GW01-1013	CAA06-GW01P-1013	CAA06-GW02-1013	CAA06-GW03-1013	CAA06-GW04-1013	CAA06-GW05-1013	CAA06-GW06-1013
Sample Date	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13	10/02/13
<b>Chemical Name</b>							
<b>Total Metals (µg/l)</b>							
Aluminum	50 U	50 U	19 J	48 J	50 U	50 U	50 U
Antimony	0.49 B	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.29 B
Arsenic	5.9	6.3	21	33	16	26	33
Barium	15	15	12	8.9	25	12	14
Beryllium	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Calcium	21,000	22,000	15,000 J	43,000	47,000	43,000	38,000
Chromium	0.56 B	0.5 U	0.5 U	0.59 B	0.44 B	0.5 U	1.2 B
Cobalt	8.2	8.7	1.9	0.73 J	1	0.8 J	0.56 J
Copper	0.48 B	0.5 U	0.15 B	0.22 B	0.51 B	0.22 B	0.38 B
Cyanide	4 U	4 U	4 U	4 U	4 U	15.6	4 U
Iron	16,000	16,000	36,000 J	32,000	19,000	24,000	30,000
Lead	0.5 U	0.5 U	0.5 U	0.19 J	0.5 U	0.5 U	0.5 U
Magnesium	3,500	3,600	2,100 J	2,400	3,200	2,700	2,800
Manganese	700	710	220	210	400	360	340
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	1	1.1	1	0.46 J	2.3	0.47 J	0.75 J
Potassium	1,600	1,600	1,700 J	2,100	2,800	2,500	2,600
Selenium	1 U	1 U	0.46 B	1 U	0.61 B	0.44 B	0.45 B
Silver	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Sodium	7,900	7,800	8,000 J	10,000	12,000	9,700	9,600
Thallium	0.054 B	0.035 B	0.034 B	0.1 U	0.033 B	0.036 B	0.044 B
Vanadium	0.17 B	0.2 U	0.19 B	0.24 B	0.094 B	0.14 B	0.14 B
Zinc	7.9 B	8.7 B	5.6 B	2.2 B	5.7 B	3.7 B	3.2 B
<b>Dissolved Metals (µg/l)</b>							
Aluminum, Dissolved	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Antimony, Dissolved	0.44 B	0.5 U	0.5 U	0.33 B	0.5 U	0.5 U	0.5 U
Arsenic, Dissolved	6	6	20	25	17	22	32
Barium, Dissolved	14	15	12	7.5	26	10	14
Beryllium, Dissolved	0.12 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium, Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Calcium, Dissolved	21,000	21,000	17,000 J	38,000	47,000	42,000	36,000
Chromium, Dissolved	0.31 B	0.46 B	0.5 U	0.5 U	0.81 B	0.5 U	0.5 U
Cobalt, Dissolved	7.8	8.7	1.6	0.62 J	1.1	0.68 J	0.55 J
Copper, Dissolved	2.4 B	0.26 B	0.31 B	0.76 B	0.46 B	0.7 B	0.5 U
Iron, Dissolved	16,000	16,000	37,000 J	29,000	19,000	23,000	30,000
Lead, Dissolved	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Magnesium, Dissolved	3,400	3,400	2,300 J	2,100	3,300	2,700	2,700
Manganese, Dissolved	670	700	200	170	410	280	330
Mercury, Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel, Dissolved	1.1	1.2	0.6 J	0.5 U	1.6	0.5 U	0.29 J
Potassium, Dissolved	1,500	1,500	1,900 J	1,800	2,800	2,400	2,500
Selenium, Dissolved	1 U	0.42 B	1 U	1 U	0.72 B	0.42 B	0.91 B
Silver, Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Sodium, Dissolved	8,200	7,300	8,700 J	9,800	11,000	9,500	9,300
Thallium, Dissolved	0.038 B	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.051 B
Vanadium, Dissolved	0.14 J	0.2 U	0.2 U	0.071 B	0.2 U	0.094 B	0.2 U
Zinc, Dissolved	16	5.4 B	4.6 B	8.4 B	2.3 B	4.3 B	5.3 B
<b>Wet Chemistry</b>							
Alkalinity (mg/l)	71	NA	58	120	140	130	120
Chloride (mg/l)	9.3	NA	10	9.5	11	11	9.5
Methane (mg/l)	2.3	NA	0.73	2.3	5.4	5.3	8.2
Nitrate (mg/l)	0.25 U	NA	0.25 U	0.095 J	0.25 U	0.25 U	0.25 U
Nitrite (mg/l)	0.25 U	NA	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
pH (pH units)	6.5	NA	6.4	6.4	6.7	6.6	6.5
Sulfate (mg/l)	4.6 J	NA	0.93 J	1 J	0.9 J	1.1 J	5 U
Sulfide (mg/l)	1 U	NA	1 U	1 U	1 U	1 U	1 U
Total organic carbon (TOC) (mg/l)	2.4	NA	2.8	3.5	3	3.3	3.2

## Notes:

Shading indicates detections

NA - Not analyzed

B - Analyte not detected significantly above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

U - The material was analyzed for, but not detected

mg/l - Milligrams per liter

µg/l - Micrograms per liter

## Appendix H

### Human Health Risk Assessment

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# Baseline Human Health Risk Assessment

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## H.1 Introduction

Appendix H presents the baseline human health risk assessment (HHRA) for CAX Area of Concern (AOC) 6 TNT Subareas. The HHRA was conducted to assess the nature, magnitude, and probability of potential harm to public health posed by exposure to site-related constituents in soil and groundwater at AOC 6. The data evaluated in the HHRA are discussed in Section 5 of the Remedial Investigation (RI) report. The HHRA incorporates the general methodology described in the following U.S. Environmental Protection Agency (USEPA) documents:

- Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A (USEPA, 1989)
- Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part D (USEPA, 2001)
- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004)
- USEPA Region III Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening (USEPA, 1993)

The HHRA consists of the following components:

- Human Health Conceptual Site Model
- Identification of chemicals of potential concern (COPCs)
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Assessment

These components are described in the following sections. Risk calculation spreadsheets for AOC 6 were prepared in accordance with *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part D* (USEPA, 2001) to screen for COPCs and to calculate risks estimates associated with the COPCs. These spreadsheets are presented in Appendix I.

## H.2 Human Health Conceptual Site Model

The human health conceptual site model (CSM) showing potential human health exposure scenarios for current and potential future site use is provided in Table 1 of Appendix I and graphically on Figure H-1. The CSM provides a current understanding of the source(s) of contamination, release and transport mechanisms, current and potential future land use, and identifies potentially complete human exposure pathways for AOC 6.

The history of the AOC 6 TNT subareas is unknown. The subareas were originally identified as potential waste sources through a review of historical aerial photographs, engineering drawings, and site reconnaissance visits (Weston, 1999). Potential historical leakage or discharge from the former TNT Graining House sump and/or TNT Catch Boxes are the primary known and suspected sources of contamination at the AOC 6 TNT subareas.

The primary release mechanisms transporting the COPCs from the source, through environmental media, and to potential receptors are:

- Direct release of waste constituents to downgradient surface soil
- Leaching of chemicals or metals from surface soil to subsurface soil and subsequently to groundwater via infiltrating precipitation
- Surface runoff from source areas to downgradient surface soil, surface water, and sediment (surface water and sediment are not evaluated in this HHRA, but as part of the Penniman Lake RI)

- Future household use of groundwater from wells

The AOC 6 TNT subareas are wooded and moderately vegetated with shrubs. The subareas are located within the confines of CAX and access is restricted to the general public. Navy and DoD personnel have access to the AOC 6 TNT subareas and they are currently used by Navy and DoD personnel for recreational activities such as jogging, hunting, and fishing. Therefore, there is the potential for base workers and adult/child recreational users (Navy and DoD personnel and their families) to access the site. The current receptors could be exposed to surface soil through incidental ingestion, dermal contact, and inhalation of volatile and/or particulate emissions.

Although there are no plans for future site development, future site use is unknown. Therefore, potential future human receptors include the current receptors, and if the investigation area is developed for future use, future residents or construction workers. Future receptors could be exposed to surface and subsurface soil if future development activities occur at the investigation area, such as construction of future residential housing or industrial buildings, or piping and utility work, and the soil is re-worked, bringing subsurface soil to the surface. Exposure routes for the future exposure to soil are the same as those for current exposure to surface soil.

Although groundwater beneath the site is not currently used as a potable water supply, it was conservatively assumed that groundwater could be used as a future residential or industrial potable water supply. Additionally, due to the relatively shallow range of depths to groundwater (from about 6 feet below ground surface and deeper), it was assumed that construction workers could be exposed to groundwater during future excavation activities.

Since historic site use is not associated with significant volatile organic compound (VOC) contamination, and volatile constituents were not found to be potential constituents of concern during previous investigations, VOCs were not included in groundwater analysis. Therefore, the groundwater to air pathway is not considered a complete exposure pathway.

## H.3 Identification of COPCs

The identification of COPCs includes data collection, evaluation, and screening to identify those chemicals which contribute the most to the total risk estimates associated with the site. The data collection and evaluation involve gathering and reviewing the available site data and identifying a set of data for the risk assessment that meets project-specific data quality objectives. Once compiled, the data set is screened against concentrations that are protective of human health to focus the risk assessment efforts on the constituents and media of potential concern for human receptors.

### H.3.1 Data Summary

All data used in the risk assessment were fully validated and are assumed to represent current conditions. Table H-1, presented at the end of this HHRA, lists the samples evaluated by the HHRA and the analytes for each sample. Soil samples collected in October 2008, November 2008, and September 2013 and groundwater samples collected in October 2013 were included in the risk assessment. Groundwater samples were analyzed for both total and dissolved metals. The total and dissolved concentrations of aluminum, iron, and manganese were compared for each monitoring well to note if there were significant differences (over an order of magnitude) between the two in any of the wells, following USEPA guidance (USEPA, 1992). Because no significant differences were noted between total and dissolved concentrations of these indicator metals in any of the wells, the total metals data were used to evaluate risks associated with potable use of groundwater. The total metals data were also used for the construction worker exposure to groundwater because the construction worker would be exposed to the groundwater directly in the ground (in an excavation). Groundwater samples collected using direct push sampling techniques (DPT) in November 2008 were not evaluated in the risk assessment. Groundwater samples collected using DPT sampling methodology are not typically used for HHRA due to the higher suspended solids and particulates in groundwater samples collected using DPT.

The data collected during site investigations were evaluated to assess their reliability for use in the quantitative risk assessments. The following criteria were used to assess data usability based on past discussions with USEPA and the Navy:

- Estimated values flagged with a J, K, or L were treated as unqualified detected concentrations.
- Data qualified with an R (rejected) were not used in the risk assessment.
- Data qualified with a B (blank contamination) were used in the risk assessment as if the results were non-detects, with the blank-related concentrations of each constituent used as the sample detection limit.
- For duplicate samples, the maximum concentration between the two samples was used as the sample concentration.
- Non-detected values were included in the risk assessment and exposure point concentration (EPC) calculations at the detection limit using ProUCL (USEPA, 2013a).

Detailed results for sampling that was performed at AOC 6 are presented in Section 2 of the RI report.

### H.3.2 Selection of COPCs

The selection of COPCs was based on the criteria presented in the USEPA Region III technical guidance manual (USEPA, 1993) and *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part D* (USEPA, 2001). The maximum detected concentration of each constituent for each medium was compared to the criteria discussed below to select the COPCs. If the maximum concentration exceeded the criteria, the constituent was selected as a COPC. Constituents that were not detected in any of the samples or were detected at concentrations less than the criteria were not identified as COPCs. The following screening criteria were used in the HHRA, as presented in Tables 2.1 through 2.5 in Appendix I:

- **Comparison with Health-based Criteria for Soil:** Soil data were compared to the USEPA residential soil regional screening levels (RSLs) (USEPA, 2014a). RSLs based on noncarcinogenic effects were based on a hazard quotient of 0.1 to account for exposure to multiple constituents with the same target organ or target effect. RSLs based on carcinogenic effects were based on a  $1 \times 10^{-6}$  carcinogenic risk as presented in the RSL table. Lead concentrations were compared to the USEPA residential child soil screening value of 400 milligrams per kilogram (mg/kg) (USEPA, 1994a). Soil data were also compared to generic USEPA risk-based soil screening levels (SSLs) for protection of groundwater (noncarcinogenic effects based on a hazard quotient of 0.1, as was done for RSLs). SSLs were not used to identify COPCs but are discussed in Section H.6 as an indication of potential leaching from soil to groundwater at levels of potential concern.
- **Comparison with Health-based Criteria for Soil-to-air Pathway:** The maximum detected concentrations in soil were used to model the maximum ambient air concentrations. Volatile and fugitive emissions from soil were estimated using the volatilization factor (VF) and particulate emission factor (PEF) approach presented in USEPA's soil screening guidance (USEPA, 1996). The modeled air concentrations were compared to USEPA RSLs for ambient air (USEPA, 2014a). RSLs based on noncarcinogenic effects were based on a hazard quotient of 0.1 to account for exposure to multiple constituents. RSLs based on carcinogenic effects were based on a carcinogenic risk of  $1 \times 10^{-6}$  as presented in the RSL table.
- **Comparison with Health-based Criteria for Groundwater:** Groundwater data were compared to the USEPA RSLs for tap water (USEPA, 2014a). RSLs that are based on noncarcinogenic effects were based on a hazard quotient of 0.1 to account for exposure to multiple constituents. RSLs based on carcinogenic effects were based on a carcinogenic risk of  $1 \times 10^{-6}$  as presented in the RSL table. Lead concentrations in groundwater were compared to the federal action level of 15 micrograms per liter ( $\mu\text{g/L}$ ) (USEPA, 2009a).
- **Essential Human Nutrients:** Constituents that are considered essential nutrients and are toxic only at very high doses were eliminated from the quantitative risk analysis. These constituents are calcium, magnesium, potassium, and sodium. Although iron and manganese are also considered essential nutrients and are only toxic at very high doses, they were included in the HHRA because toxicity values are available for these two nutrients.
- **Comparison to Background Concentrations:** Background concentrations were not used to identify/eliminate any of the COPCs. However, background concentrations are included in the screening tables, if available, and

are discussed in the risk characterization, if applicable (i.e., constituents resulting in risks above target risk levels may be associated with background conditions). Background concentrations for surface soil are the 95 percent upper tolerance level (95% UTL) from the CAX/Yorktown background surface soil samples and background concentrations for the combined surface and subsurface soil are the lower of the 95% UTL from the CAX/Yorktown background surface soil samples and subsurface soil samples (CH2M HILL, 2012). Background values for the groundwater are the groundwater concentrations in the two site-specific upgradient monitoring wells, CAA06-MW01 and CAA06-MW06.

Four of the soil samples (two surface soil and two subsurface soil) collected in September 2013 included analysis for both total and hexavalent chromium. Because hexavalent chromium data were available, the hexavalent chromium concentrations in soil were screened using hexavalent chromium RSLs and the total chromium concentrations in soil were screened using trivalent chromium RSLs. The uncertainties associated with this screening approach are discussed in Section H.7. Groundwater samples were not collected for hexavalent chromium analysis; however, none of the six groundwater samples had detections of chromium.

### H.3.3 COPCs

Table H-2, presented at the end of this HHRA, lists the constituents identified as COPCs for each medium, as summarized below.

#### Surface Soil:

- One semivolatile organic compound (SVOC) (2,4-dinitrotoluene)
- Five explosives (1,3-dinitrobenzene, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, and 4-amino-2,6-dinitrotoluene)
- Seven metals (aluminum, arsenic, cobalt, iron, lead, thallium, and vanadium)
- No COPCs were identified for particulate or volatile emissions from surface soil to air

#### Surface and Subsurface Soil:

- One SVOC (2,4-dinitrotoluene)
- Five explosives (1,3-dinitrobenzene, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, and 4-amino-2,6-dinitrotoluene)
- Eight metals (aluminum, arsenic, hexavalent chromium, cobalt, iron, lead, thallium, and vanadium)
- No COPCs were identified for particulate or volatile emissions from surface and subsurface soil to air

#### Groundwater:

- Five total metals (arsenic, cobalt, cyanide, iron, and manganese)

## H.4 Exposure Assessment

Exposure refers to the potential contact of an individual with a constituent. The exposure assessment identifies pathways and routes by which an individual may be exposed to the COPCs, and estimates the magnitude, frequency, and duration of potential exposure. Constituent intakes and associated health risks are only quantified for complete exposure pathways.

The components of exposure assessment include the following:

- Development of the CSM for human health
- Calculation of EPCs
- Development of exposure assumptions for potentially complete exposure pathways
- Calculation of intake for COPCs using calculated EPCs and exposure assumptions

### H.4.1 Conceptual Site Model for Human Health

The CSM for human health is presented in Section H.2 and Figure H-1.

The potentially exposed populations evaluated in the risk assessment are shown in Figure H-1 and Appendix I, Table 1. Potential current receptors include base workers, and Navy and DoD personnel and their families who may use the site for recreational activities such as jogging, hunting, and fishing. These receptors may be exposed to the surface soil.

Future site use and future receptors will most likely remain the same as the current site use and receptors. However, although there are no plans for future site development, future site use is unknown. Therefore, potential future human health receptors include the current receptors, and if the investigation area is developed for future use, future residents or construction workers. Future receptors could be exposed to surface and subsurface soil if future development activities occur at the investigation area, such as future residential housing or industrial buildings are constructed, or piping and utility work performed, and the soil is re-worked, bringing subsurface soil to the surface.

Although groundwater beneath the site is not currently used as a potable water supply, it was conservatively assumed that groundwater could be used as a future residential or industrial potable water supply. Additionally, due to the relatively shallow range of depths to groundwater (from about 6 feet below ground surface and deeper), it was assumed that construction workers could be exposed to groundwater during future excavation activities.

Since historic site use is not associated with significant VOC contamination, and volatile constituents were not found to be potential constituents of concern during previous investigations, VOCs were not included in groundwater analysis. Therefore, the groundwater to air pathway is not considered a complete exposure pathway.

In summary, current receptors and potentially complete exposure routes for quantitative evaluation are:

- **Base Worker:** Incidental ingestion and dermal contact with surface soil.
- **Recreational User (adult and child):** Incidental ingestion and dermal contact with surface soil.

Future receptors and potentially completely exposure routes include the following:

- **Base Worker:** Incidental ingestion and dermal contact with surface and subsurface soil; ingestion of shallow groundwater.
- **Recreational User (adult and child):** Incidental ingestion and dermal contact with surface and subsurface soil.
- **Resident (adult and child):** Incidental ingestion and dermal contact with surface and subsurface soil; ingestion of shallow groundwater, and dermal contact with shallow groundwater while bathing/showering.
- **Construction worker:** Incidental ingestion and dermal contact with surface and subsurface soil; dermal contact with shallow groundwater in an open excavation.

### H.4.2 Calculation of Exposure Point Concentrations

Exposure is quantified by estimating the EPCs for COPCs in environmental media and constituent intake (ingestion, dermal absorption) by the receptor. EPCs are the estimated constituent concentrations that a receptor may contact and are specific to each exposure medium. The EPCs for AOC 6 are provided in Tables 3.1.RME through 3.3.RME of Appendix I.

EPCs may be directly monitored or estimated using environmental models. Constituent concentrations in surface soil, surface and subsurface soil, and groundwater were measured for this assessment. Fate and transport modeling was used to estimate constituent concentrations in volatile and particulate emissions from soil for the COPC screening only, as COPCs were not identified for this pathway.

Concentrations in volatile and particulate emissions from soil were estimated using the VF and PEF approach presented in *Supplemental Guidance for Developing Soil Levels for Superfund Sites* (USEPA, 2002). For volatile

constituents, PEFs and VFs were used to estimate potential ambient air concentrations. For non-volatile constituents, PEFs were used to estimate potential ambient air concentrations. VFs were calculated using site-specific input parameters and default values and are provided in Appendix I, Table 2.2A. The calculated air concentrations are shown in Appendix I, Tables 2.2 and 2.4.

ProUCL software Version 5.0 (USEPA, 2013a) was used to calculate the EPCs. The recommendations outlined in the ProUCL software documentation (USEPA, 2013a) were followed to select the appropriate 95 percent upper confidence levels (95 percent UCLs) used as the EPCs. The maximum detected concentration was used as the EPC where the estimated 95 percent UCL was greater than the maximum detected concentration or where only one detected concentration was available for a data grouping, or where less than eight samples were available for a soil data grouping. Following USEPA groundwater guidance (USEPA, 2014b), a minimum of 3 wells in the core of the plume should generally be used to calculate the groundwater EPC. Therefore, as six groundwater samples were collected, a 95% UCL was calculated for all groundwater COPCs. The arithmetic mean concentration of detected values was used as the EPC for lead. The ProUCL output is included in Appendix I.

The EPCs for groundwater were calculated using all of the site-related groundwater samples because there is no groundwater plume at the site and no groundwater hot spots were identified.

### H.4.3 Estimation of Chemical Intakes for Individual Pathways

Chemical intake is the amount of the chemical constituent entering the receptor's body. The quantification of exposure is based on an estimate of the chronic daily intake (CDI), the average amount of the COPC entering the receptor's body per day. Chemical intake estimates for the ingestion and dermal exposure pathways are generally expressed as follows:

$$CDI = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

Where

- CDI = chronic daily intake (mg/kg-day)
- C = chemical concentration (mg/L, mg/kg)
- CR = contact rate (L/day, mg/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (days)

For the dermal pathway, the contact rate incorporates the skin surface area in contact with the exposure medium (soil or groundwater) and an absorption (soil) or permeability (groundwater) factor.

For soil, the contact rate is calculated as follows:

$$CR = SA \times SSAF \times DABS$$

Where

- SA = Skin surface area in contact with soil (cm<sup>2</sup>)
- SSAF = soil to skin adherence factor (mg/cm<sup>2</sup>-day)
- DABS = dermal absorption factor, chemical specific (unitless)

Chemical-specific skin absorption fractions for soil were obtained from USEPA's Dermal Exposure Assessment Guidance (USEPA, 2004) and the USEPA RSL table (2014a), which recommend 10.2 percent for 2,4-dinitrotoluene, 3.2 percent for 2,4,6-trinitrotoluene, 0.6 percent for 2-Amino-4,6-dinitrotoluene, 0.9 percent for 4-Amino-2,6-dinitrotoluene, 10 percent for all other explosives, 3 percent for arsenic, and 1 percent for all other inorganics.

For groundwater, the contact rate is calculated as follows:

$$CR = DA_{event} \times SA$$

Where

DA<sub>event</sub> = dermally absorbed dose per event (mg/cm<sup>2</sup>-event)

SA = Skin surface area in contact with water (cm<sup>2</sup>)

The dermally absorbed dose per event is calculated using chemical-specific permeability constants and additional chemical specific parameters which are shown in supplemental tables to the Table 7 series in Appendix I.

The intake and exposure equations require exposure parameters that are specific to each exposure pathway. Many of the exposure parameters have default values, which were used for this assessment. These assumptions, based on estimates of body weights, media intake levels, and exposure frequencies and duration, are provided in USEPA guidance (USEPA, 1989; 1991; 1993; 2004; 2011; 2014c), and Virginia Department of Environmental Quality (VDEQ) guidance (2003). Other assumptions (for example, for the recreational user and construction worker scenarios) require consideration of location-specific information and were made using professional judgment. Tables 4.1.RME through 4.3.RME and Tables 4.1.CTE through 4.3.CTE of Appendix I present the exposure parameters that were used for the exposure scenarios evaluated in the risk assessment. RME scenario exposure parameters were compiled for all scenarios; CTE parameters were compiled only for scenarios where the RME noncarcinogenic hazard or carcinogenic risk for an environmental medium was greater than the noncarcinogenic hazard or carcinogenic risk target levels (cumulative noncarcinogenic hazard index (HI) >1, and carcinogenic risk >1 × 10<sup>-4</sup>).

## H.5 Toxicity Assessment

Toxicity assessment defines the relationship between the magnitude of exposure and possible severity of adverse effects, and weighs the quality of available toxicological evidence. Toxicity assessment generally consists of two steps: hazard identification and dose-response assessment. Hazard identification is the process of characterizing the potential adverse effects from exposure to the chemical and the type of health effect involved. Dose-response assessment is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the constituent administered or received and the incidence of adverse health effects in the exposed population. Toxicity criteria (e.g., reference doses [RfDs] and cancer slope factors [CSFs]) are derived from the dose-response relationship.

USEPA recommends that a tiered approach be used to obtain the toxicity values (RfDs and CSFs) that are used to estimate noncarcinogenic hazards and carcinogenic risks (USEPA, 2003a). The hierarchy of toxicity value sources is the following:

1. Integrated Risk Information System (IRIS) (USEPA, 2014d)
2. Provisional Peer-Reviewed Toxicity Values (PPRTV)
3. Other peer-reviewed USEPA and non-USEPA sources (USEPA, 2013b), including the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997), California Environmental Protection Agency Toxicity Criteria Database (2014), New Jersey Department of Environmental Protection chromium work group (NJDEP, 2009), and Agency for Toxic Substances and Disease Registry (2014)

The use of toxicity values from sources other than IRIS increases the uncertainty of the quantitative risk estimates. Some of the COPCs elicit both systemic (noncarcinogenic) toxic effects and cancer (carcinogenic) effects. Because of this, these constituents are evaluated as both noncarcinogens and carcinogens. The health risks for carcinogenic and noncarcinogenic effects were estimated separately based on different toxicity values.

Hexavalent chromium was analyzed in a subset of the soil samples, but was not analyzed in any of the groundwater samples. Hexavalent chromium was detected and identified as a COPC for combined surface and subsurface soil but was not detected in the surface soil. As hexavalent chromium was not detected in the surface soil, the total chromium data were compared to the screening values for trivalent chromium to determine that total chromium was not a COPC for surface soil. Chromium was not detected in groundwater.

The non-carcinogenic toxicity values are provided in Table 5.1 of Appendix I, and the carcinogenic toxicity values are provided in Table 6.1 of Appendix I.

### H.5.1 Toxicity Information for Noncarcinogenic Effects

Noncarcinogenic health effects include a variety of toxic effects on body systems, ranging from toxicity to the kidneys to central nervous system disorders. The toxicity of a chemical is assessed through a review of toxic effects noted in short-term (acute) animal studies, long-term (chronic) animal studies, and epidemiological investigations.

USEPA (1989) defines the chronic RfD as a dose that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound (for example, 7 years to a lifetime), and consider uncertainty in the toxicological database and sensitive receptors. Subchronic RfDs (applicable for exposures less than 7 years), which are all provisional values (that is, not verified by USEPA), were used for the construction worker scenario, if available. Chronic RfDs were used to evaluate noncarcinogenic risks to all other receptors included in the HHRA. In the development of RfDs, all available studies examining the toxicity of a chemical following exposure are considered on the basis of scientific merit. The lowest dose level at which an observed toxic effect occurs is identified as the lowest observed adverse effect level, and the dose at which no effect is observed is identified as the no observed adverse effect level. Several uncertainty factors (UFs) may be applied to account for uncertainties such as limited data, extrapolation of data from animal studies to human exposures, or the use of subchronic studies to develop chronic criteria. These UFs range from 10 to 10,000, and are based on professional judgment. Consequently, there are varying degrees of uncertainty in the toxicity criteria, which range from 1 to 3,000 for the COPCs identified for this site.

In accordance with USEPA guidance, oral RfDs were adjusted from administered dose (oral) to absorbed dose (dermal) to evaluate dermal toxicity. When appropriate, the RfDs were adjusted using oral absorption factors (USEPA, 2004). This adjustment is shown in Table 5.1 in Appendix I.

### H.5.2 Toxicity Information for Carcinogenic Effects

Potential carcinogenic effects are quantified as CSFs that convert estimated exposures directly to incremental lifetime carcinogenic risks.

CSFs may be derived from the results of chronic animal bioassays, human epidemiological studies, or both. Animal bioassays are usually conducted at dose levels that are much higher than are likely to be encountered in the environment. This design detects possible adverse effects in the relatively small test populations used in the studies. The actual risks from exposure to a potential carcinogen are not likely to exceed the estimated risks and are probably much lower or even zero.

As was done for oral RfDs, oral CSFs were adjusted from administered dose (oral) to absorbed dose (dermal) to evaluate dermal toxicity. When appropriate, the CSFs were adjusted using oral absorption factors (USEPA, 2004). This adjustment is shown in Table 6.1 in Appendix I.

### H.5.3 Approach for Potential Mutagenic Effects

Consistent with the cancer guidelines and supplemental guidance (USEPA, 2005a and 2005b), cancer risks were estimated using age-dependent adjustment factors (ADAFs) for COPCs which act via a mutagenic mode of action (MMOA). Hexavalent chromium was the only COPC that is categorized as a chemical with a MMOA.

The calculation of cancer risk using ADAFs is presented in the Table 7 series in Appendix I. Because chemical-specific data are not available for hexavalent chromium, default ADAFs, as included in *Derivation of RBCs for Carcinogens that Act Via a Mutagenic Mode of Action and Incorporate Default ADAFs* (USEPA, 2006), were used for the MMOA evaluation. The default ADAFs used to adjust the CSF are 10 for 0 to 2-year-olds, 3 for 2- to 6-year-olds, 3 for 6- to 12-year-olds, and 1 for 16- to 26-year-olds. The CSF was multiplied by the appropriate ADAF to derive the age-specific CSF for a receptor to calculate the total carcinogenic risk. Additionally, the exposure factors for children 0 to 2 years old and 2 to 6 years old were assumed to be the same as the parameters for a child 0 to 6 years old, except for the exposure duration, which was 2 years and 4 years, respectively. The exposure factors for the adult residential receptor were used for residents 6 to 16 years old and 16 to 26 years old, with the exception of the exposure durations, which were 10 years for each age-range.

## H.5.4 Constituents for Which USEPA Toxicity Values Are Not Available

Quantitative oral toxicity criteria are not available for lead. As a screening tool, lead is screened against 400 mg/kg in soil and 15 µg/L in groundwater, based on residential exposure. The potential risks associated with residential exposures to lead are addressed using the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model and the Adult Lead Model (ALM), as described in Section H.6.1.

## H.6 Risk Characterization

Risk characterization combines the results of the previous elements of the risk assessment to evaluate the potential health risks associated with exposure to the COPCs. The risk characterization is then used as an integral component in remedial decision making and selection of potential remedies or actions, as necessary.

### H.6.1 Methods for Estimating Risks

Potential human health risks are discussed independently for carcinogenic and noncarcinogenic constituents because of the different toxicological endpoints, relevant exposure duration, and methods used to characterize risk. Exposure to some constituents may result in both noncarcinogenic and carcinogenic effects (i.e., arsenic), and therefore, these constituents were evaluated in both groups. The methodology used to estimate noncarcinogenic hazards and carcinogenic risks are described below.

#### H.6.1.1. Noncarcinogenic Hazard Estimation

Noncarcinogenic health risks are estimated by comparing the calculated exposures to RfDs. The calculated intake divided by the RfD is equal to the hazard quotient (HQ):

$$HQ = \text{Intake} / \text{RfD}$$

The intake and RfD represent the same exposure route (i.e., oral intakes are divided by oral RfDs). An HQ that exceeds 1 (i.e., intake exceeds the RfD) indicates that there is a potential for adverse health effects associated with exposure to that constituent.

To assess the potential for noncarcinogenic health effects posed by exposure to multiple constituents, an HI approach is used (USEPA, 1986). This approach assumes that noncarcinogenic hazards associated with exposure to more than one constituent are additive (HI = sum of the HQs). Synergistic or antagonistic interactions between constituents are not considered. The HI may exceed 1 even if all of the individual HQs are less than 1. HIs may be added across exposure routes and media to estimate the total noncarcinogenic health effects to a receptor posed by exposure through multiple routes and media. If the HI is greater than 1, separate HIs are estimated for each target organ to assess whether the HI for a specific target organ is greater than 1. A target organ-specific HI greater than 1 indicates there is some potential for adverse noncarcinogenic health effects associated with exposure to the COPCs. If the HI for each target organ does not exceed 1, noncarcinogenic hazards are not expected.

#### H.6.1.2. Carcinogenic Risk Estimation

The potential for carcinogenic effects due to exposure to site-related constituents is evaluated by estimating the excess lifetime carcinogenic risk (ELCR). ELCR is the incremental increase in the probability of developing cancer during one's lifetime in addition to the probability to developing cancer associated with exposure to all non-site related sources of carcinogens.

Carcinogenic risk is calculated by multiplying the intake by the CSF.

$$ELCR = \text{Intake} \times \text{CSF}$$

The combined risk from exposure to multiple constituents was evaluated by adding the risks from individual constituents. Risks were also added across the exposure routes and media if an individual would be exposed through multiple routes and to multiple media.

As required under the *National Oil and Hazardous Substances Contingency Plan* (USEPA, 1994b) "[f]or known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess

upper bound lifetime cancer risk to an individual of between  $10^{-4}$  to  $10^{-6}$  using information on the relationship between dose and response." When a cumulative carcinogenic risk to a receptor under the assumed RME exposure conditions exceeds 1 in 10 thousand ( $10^{-4}$  ELCR), CERCLA generally requires remedial action to reduce risks at the site.

#### H.6.1.3. Approach for Lead

Lead concentrations less than 0.015 mg/L in groundwater (the Safe Drinking Water Act action level for lead in potable water) and less than 400 mg/kg in soil (USEPA, 1994a) are considered adequately protective of human health under residential land-use conditions. Lead was retained as a COPC when exceeding these values. Lead was identified as a COPC for surface soil and combined surface and subsurface soil. Lead does not have available published toxicity factors, and therefore potential risks associated with lead are evaluated differently than the other COPCs. The toxicity of lead is evaluated by USEPA based on blood-lead uptake using a physiologically based pharmacokinetic model called the IEUBK model.

The potential risks associated with residential/recreational exposure to lead by children were addressed using the IEUBK lead model for Windows, Version 1.1, Build 11 (USEPA, 2010). The IEUBK model provides predictions of the probability of elevated blood lead levels for children from ages 0 to 7 years with potential exposure to lead in various media. The IEUBK model was used to evaluate potential risks associated with current and future recreational and future residential child exposures to lead in soil. The arithmetic mean of the lead concentrations in surface soil (current exposure scenarios) and combined surface and subsurface soil (future exposure scenarios) was used with the default input parameters to represent site-specific exposures to lead. The IEUBK model results are expressed as the predicted geometric mean blood lead level for children and the percent of the population potentially experiencing concentrations above USEPA's recommended level of 10 micrograms per deciliter ( $\mu\text{g}/\text{dL}$ ), below which adverse manifestations are not expected. USEPA's target level for lead is less than 5 percent of the population exceeding the  $10 \mu\text{g}/\text{dL}$  blood lead level (USEPA, 1994a).

An interim approach to assessing risks associated with adult exposures to lead was developed by USEPA's Technical Review Workgroup for Lead (USEPA, 2003b) and updated in 2005 and 2009 (USEPA, 2009b). This methodology is a variation of the IEUBK model. The ALM is used to evaluate risks associated with nonresidential adult exposures to lead in soil. The model focuses on estimating fetal blood concentrations in women exposed to lead in soil (USEPA, 2003b). It was used in this risk evaluation to be protective of potentially sensitive receptors within the base worker, construction worker, and recreational populations that may be exposed to soil. Because the lead model is a probabilistic model, several of the USEPA default parameters are based on central tendency (i.e., average) values (USEPA, 2003b). Therefore, the arithmetic mean lead concentrations for surface soil, and surface and subsurface soil, served as input values for the soil concentrations.

The exposure parameters used in the ALM for ingestion and exposure frequency are the same as those used for the CTE scenarios to evaluate direct contact with soil. The soil ingestion rate of 20 mg/day was assumed for the adult recreational user; 50 mg/day was assumed for the base worker; and 100 mg/day was assumed for the construction worker. An exposure frequency of 26 days/year was assumed for the adult recreational user; 219 days/year was assumed for the base worker; and 125 days/year for the construction worker.

ALM spreadsheets provided by USEPA (2009b) were used to calculate blood lead concentrations for the various scenarios, as needed. The model results are expressed as the predicted geometric mean blood lead level for adults (that is, women of child-bearing age), the corresponding 95th percentile fetal blood lead concentrations, and the percent of the population potentially experiencing concentrations above  $10 \mu\text{g}/\text{dL}$ , below which adverse manifestations are not expected.

The only area of the site where lead concentrations in soil exceeded the screening level was in the Catch Box Ruins area. Therefore, in addition to evaluating exposure to the average concentration of lead across the site, exposure to lead within the Catch Box Ruins area was evaluated. The average concentration of lead in the samples collected from the catch box ruins area (CAA06-SO01 and -SO26) was used for this evaluation. The same exposure scenarios evaluated for lead exposure across the site were also evaluated for exposure to lead within the Catch Box Ruins.

#### H.6.1.4. Comparison to SSLs

Soil data were compared to generic SSLs from the RSL table to identify if potential leaching from soil to groundwater could result in concentrations in groundwater at levels of potential concern to human health. Tables 2.1 and 2.3 in Appendix I present SSLs, with noncarcinogenic effects based on a hazard quotient of 0.1 and carcinogenic effects based on a  $1 \times 10^{-6}$  carcinogenic risk, as presented in the RSL table. All constituents in soil, except chrysene, fluoranthene, pyrene, beryllium, chromium, and silver, had maximum detected concentrations exceed their applicable SSLs. Therefore, these constituents may be leaching to groundwater at concentrations of potential concern to human health if the groundwater is used as a potable water supply. The SSLs from the RSL table are extremely conservative, do not account for dilution or attenuation (are calculated using a dilution and attenuation factor of 1), and are only an estimate for the migration to groundwater pathway. Since groundwater data is available at AOC 6, the actual groundwater concentrations were used to evaluate risk from exposure to groundwater.

### H.6.2 Risk Assessment Results

The results of risk estimates for AOC 6 are summarized below by receptor. A summary of the RME results is presented in Table H-3, and the CTE results are summarized in Table H-4, presented at the end of this HHRA. The risk calculations are presented in Tables 7.1.RME through 7.10.RME, and 7.1.CTE through 7.9.CTE in Appendix I. CTE risks were calculated only when the RME hazards exceeded the noncarcinogenic target HI of 1, or the RME carcinogenic risks exceeded the acceptable risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ . Tables 9.1.RME through 9.10.RME and 9.1.CTE through 9.9.CTE in Appendix I summarize the hazards and risks to each receptor. The constituents of concern (COCs) are identified below for each receptor. The COCs are those COPCs that contribute an HI greater than 0.1 to a cumulative target organ HI that exceeds 1, or a carcinogenic risk greater than  $1 \times 10^{-6}$  to a cumulative carcinogenic risk that exceeds  $1 \times 10^{-4}$ .

#### H.6.2.1. Current Base Worker (Tables 9.1.RME and 9.1.CTE, Appendix I)

The risk assessment assumed that a current base worker could be exposed to surface soil through incidental ingestion and dermal contact.

- Cumulative HI (RME) = 12, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative HI (CTE) = 5, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative ELCR (RME) =  $7 \times 10^{-5}$ , within target risk range.
- ALM model (surface soil across site - Tables 11.1a and 11.1b, catch box ruins surface soil - Tables 11.1c and 11.1d, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead either in surface soil across the site or surface soil in catch box ruins area.
- COC for surface soil: 2,4,6-trinitrotoluene

#### H.6.2.2. Current Adult Recreational User (Tables 9.2.RME and 9.2.CTE, Appendix I)

The risk assessment assumed that a current adult recreational user could be exposed to surface soil through incidental ingestion and dermal contact.

- Cumulative HI (RME) = 3, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative HI (CTE) = 0.3, less than target HI.
- Cumulative ELCR (RME) =  $1 \times 10^{-5}$ , within target risk range.
- ALM model (surface soil across site - Tables 11.2a and 11.2b, catch box ruins surface soil – Tables 11.2c and 11.2d, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead.
- COC for surface soil: 2,4,6-trinitrotoluene

### H.6.2.3. Current Child Recreational User (Tables 9.3.RME and 9.3.CTE, Appendix I)

The risk assessment assumed that a current child recreational user could be exposed to surface soil through incidental ingestion and dermal contact.

- Cumulative HI (RME) = 27, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative HI (CTE) = 3, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative ELCR (RME) =  $4 \times 10^{-5}$ , within target risk range.
- IEUBK model (Tables 11.3a and 11.3b, Figure 11-1, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead in soil across the site for a residential or recreational child. However, the IEUBK model (Tables 11.3c and 11.3d, Figure 11-2, Appendix I) demonstrated adverse effects above acceptable levels associated with exposure to lead in Catch Box Ruins surface soil.
- COCs for surface soil: 2,4,6-trinitrotoluene, lead (Catch Box Ruins area only)

### H.6.2.4. Future Base Worker (Tables 9.4.RME and 9.4.CTE, Appendix I)

The risk assessment assumed that a future base worker could be exposed to surface and subsurface soil through incidental ingestion and dermal contact, and groundwater used as a potable water supply through ingestion.

- Cumulative HI (RME) = 7, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil.
  - Cumulative HI (RME) for soil = 5, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 2, exceeds target HI, however, no target organ HIs exceed target level.
- Cumulative HI (CTE) = 3, exceeds target HI.
  - Cumulative HI (RME) for soil = 2, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 0.8, less than target level.
- Cumulative ELCR (RME) =  $2 \times 10^{-4}$ , exceeds target risk range, associated with arsenic in groundwater.
  - Cumulative ELCR (RME) for soil =  $3 \times 10^{-5}$ , within target risk range.
  - Cumulative ELCR (RME) for groundwater =  $2 \times 10^{-4}$ , exceeds target risk range, associated with arsenic.
- Cumulative ELCR (CTE) =  $3 \times 10^{-5}$ , within target risk range.
- ALM model (soil across site - Tables 11.4a and 11.4b, Catch Box Ruins soil – Tables 11.4c and 11.4d, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead.
- COC for soil: 2,4,6-trinitrotoluene
- COC for groundwater: arsenic

### H.6.2.5. Future Adult Recreational User (Table 9.5.RME, Appendix I)

The risk assessment assumed that a future adult recreational user could be exposed to surface and subsurface soil through incidental ingestion and dermal contact.

- Cumulative HI (RME) = 1, does not exceed target HI.
- Cumulative ELCR (RME) =  $6 \times 10^{-6}$ , within target risk range.
- ALM model (soil across site - Tables 11.5a and 11.5b, Catch Box Ruins soil – Tables 11.5c and 11.5d, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead.

### H.6.2.6. Future Child Recreational User (Tables 9.6.RME and 9.5.CTE, Appendix I)

The risk assessment assumed that a future child recreational user could be exposed to surface and subsurface soil through incidental ingestion and dermal contact.

- Cumulative HI (RME) = 11, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative HI (CTE) = 1, does not exceed target HI.
- Cumulative ELCR (RME) =  $2 \times 10^{-5}$ , within target risk range.
- IEUBK model (Tables 11.6a and 11.6b, Figure 11-3, Appendix I), conservatively run to assess recreational exposure to soil, demonstrated no adverse effects above acceptable levels associated with exposure to lead in soil across the site. However, the IEUBK model (Tables 11.6c and 11.6d, Figure 11-4, Appendix I) demonstrated adverse effects above acceptable levels associated with exposure to lead in Catch Box Ruins surface soil.
- COC for soil: 2,4,6-trinitrotoluene, lead (Catch Box Ruins area only)

#### **H.6.2.7. Future Construction Worker (Tables 9.7.RME and 9.6.CTE, Appendix I)**

The risk assessment assumed that a future construction worker could be exposed to surface and subsurface soil through incidental ingestion and dermal contact, and to groundwater in an excavation through dermal contact.

- Cumulative HI (RME) = 8, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil.
  - Cumulative HI (RME) for soil = 8, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 0.1, below target HI.
- Cumulative HI (CTE) = 2, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil.
  - Cumulative HI (RME) for soil = 2, exceeds target HI, associated with 2,4,6-trinitrotoluene.
- Cumulative ELCR (RME) =  $2 \times 10^{-6}$ , within target risk range.
- ALM model (Tables 11.7a and 11.7b, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead. ALM model results for lead in Catch Box Ruins surface and subsurface soil (Tables 11.7c and 11.7d, Appendix I) indicate upper end of range is slightly above acceptable level (probability that fetal blood lead level exceeds target level is 5.1 percent, compared to the acceptable goal of 5 percent).
- COC for soil: 2,4,6-trinitrotoluene

#### **H.6.2.8. Future Adult Resident (Non-carcinogenic Hazard, Tables 9.8.RME and 9.7.CTE, Appendix I)**

The risk assessment assumed that a future adult resident could be exposed to surface and subsurface soil through incidental ingestion and dermal contact, and to shallow groundwater through ingestion and dermal contact while showering. Carcinogenic risks were not calculated for an adult resident, but rather for a lifetime child/adult resident, following USEPA guidance.

- Cumulative HI (RME) = 14, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil and arsenic in groundwater.
  - Cumulative HI (RME) for soil = 7, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 6, exceeds target HI, associated with arsenic and iron.
- Cumulative HI (CTE) = 4, exceeds target HI, however, no target organ HIs exceed the target HI.
- Lead evaluated for the more-conservative child resident using IEUBK model, see Section H.6.2.9.
- COC for soil: 2,4,6-trinitrotoluene
- COCs for groundwater: arsenic, iron

#### **H.6.2.9. Future Child Resident (Non-carcinogenic Hazard, Tables 9.9.RME and 9.8.CTE, Appendix I)**

The risk assessment assumed that a future child resident could be exposed to surface and subsurface soil through incidental ingestion and dermal contact, and to shallow groundwater through ingestion and dermal contact while

bathing. Carcinogenic risks were not calculated for a child resident, but rather for a lifetime child/adult resident, in accordance with USEPA guidance.

- Cumulative HI (RME) = 84, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil and arsenic and iron in groundwater.
  - Cumulative HI (RME) for soil = 73, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 11, exceeds target HI, associated with arsenic and iron.
- Cumulative HI (CTE) = 22, exceeds target HI, associated with 2,4,6-trinitrotoluene in soil and arsenic in groundwater.
  - Cumulative HI (RME) for soil = 17, exceeds target HI, associated with 2,4,6-trinitrotoluene.
  - Cumulative HI (RME) for groundwater = 5, exceeds target HI, associated with arsenic.
- IEUBK model (Tables 11.6a and 11.6b, Figure 11-3, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead in soil across the site. However, the IEUBK model (Tables 11.6c and 11.6d, Figure 11-4, Appendix I) demonstrated adverse effects above acceptable levels associated with exposure to lead in Catch Box Ruins surface soil.
- COC for soil: 2,4,6-trinitrotoluene, lead (Catch Box Ruins only)
- COCs for groundwater: arsenic, iron

#### **H.6.2.10. Future Lifetime Resident (Carcinogenic Risk, Tables 9.10.RME and 9.9.CTE, Appendix I)**

The risk assessment assumed that a future lifetime child/adult resident could be exposed to surface and subsurface soil through incidental ingestion and dermal absorption, and to shallow groundwater through ingestion and dermal contact while showering.

- Cumulative ELCR (RME) =  $8 \times 10^{-4}$ , exceeds target risk range, associated with 2,4,6-trinitrotoluene, 2-nitrotoluene, arsenic, and hexavalent chromium in soil and arsenic in groundwater.
  - Cumulative ELCR (RME) for soil =  $2 \times 10^{-4}$ , exceeds target risk range, associated with 2,4,6-trinitrotoluene, 2-nitrotoluene, arsenic, and hexavalent chromium.
  - Cumulative ELCR (RME) for groundwater =  $6 \times 10^{-4}$ , exceeds target risk range, associated with arsenic.
- Cumulative ELCR (CTE) =  $2 \times 10^{-4}$ , exceeds target risk range, primarily associated with arsenic in groundwater.
  - Cumulative ELCR (RME) for soil =  $3 \times 10^{-5}$ , within target risk range.
  - Cumulative ELCR (RME) for groundwater =  $2 \times 10^{-4}$ , exceeds target risk range, associated with arsenic.
- COCs for soil: 2,4,6-trinitrotoluene, 2-nitrotoluene, arsenic, and hexavalent chromium
- COC for groundwater: arsenic

## **H.7 Uncertainty Associated with Human Health Assessment**

The risk measures used in site risk assessments are not fully probabilistic estimates of risk, but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. Thus, it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective.

### **H.7.1 Uncertainty in Data Evaluation and COPC Selection**

The sampling of site media focused on areas that were most likely affected by past site activities. Therefore, the uncertainty associated with missing a contaminated location is expected to be minimal because the investigation was focused to find the most likely and potentially highest areas of contamination. The uncertainty associated with the data analysis is minimal; all of the data were validated before being used in the HHRA. A data quality evaluation was performed on all analytical data evaluated in the HHRA, as discussed in Section 5 of the RI.

The general assumptions used in the COPC selection process were conservative to ensure that true COPCs were not eliminated from the quantitative risk assessment and that the reasonable maximum risk was estimated. RSLs based on residential assumptions were used to select the COPCs for all exposure scenarios, including non-residential scenarios.

Four of the soil samples (two surface soil and two subsurface soil) included analysis for hexavalent chromium, while all soil samples (twenty-two surface soil and twenty-two subsurface soil) were analyzed for total chromium. Because hexavalent chromium data were available, the hexavalent chromium concentrations in soil were screened using hexavalent chromium RSLs and the total chromium concentrations in soil were screened using trivalent chromium RSLs. However, there is some uncertainty associated with the samples where only total chromium was analyzed. It is possible the risks were underestimated in the HHRA if hexavalent chromium was present in the soil at locations where it was not analyzed.

A comparison of site concentrations to background concentrations was not used to select the COPCs. Therefore, it is possible that any of the metals identified as COPCs and COCs may be associated with background conditions. Arsenic was identified as a COC in surface and subsurface soil. Arsenic concentrations in surface and subsurface soil ranged from 1.1 mg/kg to 20.9 mg/kg. More than half of these detections were below the 95 percent UTL from the CAX/Yorktown background value of 5.54 mg/kg for surface and subsurface soil. Therefore, it is possible some of the risk associated with exposure to arsenic in soil is from background conditions. Additionally, the detected concentrations of arsenic in the groundwater samples collected from the site-related monitoring wells were within the range of concentrations detected in the site-specific background monitoring wells. Therefore, the potential risks associated with exposure to arsenic in groundwater may be associated with background conditions.

Detection limits for constituents that were not detected within a media were compared to the screening levels to determine if there are any non-detected constituents with detection limits above the screening level. There were a few SVOCs, explosives, and metals detected with detection limits above the screening level, however, most were within an order of magnitude or two above the screening level, and would not result in unacceptable risks if they were present at concentrations below their detection limit. Based on this evaluation, there are not expected to be any non-detected analytes present at the site that would result in unacceptable risks, or changes to the results of the HHRA evaluation.

## **H.7.2 Uncertainty Associated with Exposure Assessment**

Uncertainty in the exposure assessment was generally treated with conservative decision rules and assumptions, and therefore the uncertainty likely overestimates actual exposure to COPCs. Several exposure pathways evaluated by the HHRA, such as residential land use, are hypothetical and are not likely to occur in the future at AOC 6. It is also not likely that shallow groundwater would be used as a potable or industrial water supply because of the availability of better water supplies with respect to both water quality and quantity. Most of the exposure factors used for quantitation of exposure are generally conservative and reflect upper-bound assumptions for the exposure.

The percent of a constituent absorbed through the skin is another source of uncertainty and is likely to be affected by many parameters, including soil loading, moisture content, organic content, pH, and presence of other constituents. The availability of a constituent for absorption through the skin depends on site-specific fate and transport properties of the chemical species available for eventual absorption. Constituent concentrations, specific properties of the constituent, and the kinetics of constituents being released all affect the amount of a constituent that is absorbed. These factors contribute to the uncertainty associated with dermal absorption estimates, and make it difficult to quantify the amount of certain constituents absorbed through the skin from soil.

The future soil exposure scenario adds additional conservatism by assuming that the subsurface soil will become surface soil during any future construction activities, and that future receptors may come in contact with what is the current surface soil and current subsurface soil in the future.

### H.7.3 Uncertainty Associated with Toxicity Assessment

Uncertainty associated with the noncarcinogenic toxicity factors is included in the toxicity tables for AOC 6 in Appendix I. Several UFs were applied to extrapolate dose points from animal studies to humans. These UFs range between 1 and 3,000. Therefore, there is a high degree of uncertainty in the noncarcinogenic toxicity criteria based on the available scientific data for each constituent.

The uncertainty associated with CSFs is mostly due to the low dose extrapolation where carcinogenicity at low doses is assumed to be a linear response. This is a conservative assumption, which introduces a high uncertainty into slope factors that are extrapolated from this area of the dose-response curve. The CSFs are based on the assumption that there is no threshold level for carcinogenicity. Therefore, CSFs developed by USEPA represent upper-bound estimates. Carcinogenic risks generated in this assessment should be regarded as an upper-bound estimate on potential carcinogenic risks, rather than an accurate representation of carcinogenic risk. The true carcinogenic risk is likely to be less than the predicted value (USEPA, 1989). Uncertainty is also associated with the application of the ADAFs for chromium due to its mutagenic MOA; this may overestimate or underestimate risks. Additionally, generic ADAFs were used in the MMOA calculations because no chemical specific ADAFs are available for the COPCs.

Use of provisional toxicity factors (such as values from ATSDR, HEAST, California EPA, and New Jersey DEP) increases the uncertainty of the quantitative hazard and risk estimates. These provisional values were used to provide a quantitative estimate rather than a merely qualitative risk discussion; however, these values should be interpreted cautiously because USEPA has not approved these toxicity values.

CSFs developed by USEPA represent upper-bound estimates. Carcinogenic risks generated in this assessment should be regarded as an upper-bound estimate of the potential carcinogenic risks rather than an accurate representation of carcinogenic risk.

A large degree of uncertainty is associated with the oral-to-dermal adjustment factors (based on constituent-specific gastrointestinal absorption factors) used to transform the oral RfDs based on administered doses to dermal RfDs based on absorbed doses. It is not known if the adjustment factor results in an underestimate or overestimate of the actual toxicity associated with dermal exposure.

### H.7.4 Uncertainty in Risk Characterization

The ALM and IEUBK models demonstrated no adverse effects above acceptable levels associated with lead in all exposure scenarios. However, one surface soil sample (CAA06-SO26-000H-0913, the 3-point composite soil sample) had a lead concentration of 1,100 mg/kg, which was much higher than other lead concentrations, ranging from 4 to 580 mg/kg. This soil sample also had the highest detection of 2,4,6-trinitrotoluene. It is possible that this 3 point composite sample could be considered a hot spot. If that is the case, then the risk from lead could be underestimated for a receptor who is only exposed to soil at this location and not across the site. Therefore, the ALM and IEUBK models were also used to evaluate exposure to lead in the Catch Box Ruins area, the location of this elevated sample. The results of this hot spot lead evaluation are discussed in Section H.6.2.

The uncertainties identified in each component of risk assessment ultimately contribute to uncertainty in risk characterization. The addition of risks and HIs across pathways and constituents contributes to uncertainty based on chemical interactions such as additivity, synergism, potentiation, and susceptibility of exposed receptors.

## H.8 Human Health Risk Summary

The HHRA was conducted to evaluate the current and future potential human health risks associated with exposure to surface soil, surface and subsurface soil, and groundwater at AOC 6.

Tables H-3 and H-4, presented at the end of this HHRA, and Tables 9.1.RME through 9.10.RME and 9.1.CTE through 9.9.CTE in Appendix I summarize the RME and CTE potential hazards and risks to each receptor. Tables 10.1.RME through 10.9.RME and 10.1.CTE through 10.6.CTE, Appendix I, show the receptor scenarios with cumulative HIs greater than 1, or total carcinogenic risks greater than  $1 \times 10^{-4}$ . The COPCs that contribute HIs greater than 0.1 or carcinogenic risks greater than  $1 \times 10^{-6}$  are included in the tables. COCs are identified for the

scenarios with potentially unacceptable risks. The COCs are those COPCs that contribute an HI greater than 0.1 to a cumulative target organ HI that exceeds 1 or a carcinogenic risk greater than  $1 \times 10^{-6}$  to a cumulative carcinogenic risk that exceeds  $1 \times 10^{-4}$ . Risk estimates and COCs are summarized below.

### Base Worker

- Exposure to surface soil under current scenario and exposure to surface and subsurface soil and groundwater under future scenarios
- Current scenario
  - Total HI (RME and CTE) for exposure to surface soil exceeds target HI.
  - Total ELCR (RME and CTE) for exposure to surface soil within target risk range
  - COC for surface soil is 2,4,6-trinitrotoluene
- Future scenario
  - Total HI (RME and CTE) for exposure to soil and groundwater exceeds target HI.
  - Total ELCR (RME) for exposure to soil and groundwater exceeds target risk range, total ELCR (CTE) within target risk range
  - COC for soil is 2,4,6-trinitrotoluene
  - COC for groundwater is arsenic

### Recreational User (Adult and Child)

- Exposure to surface soil under current scenario and exposure to surface and subsurface soil under future scenarios
- Current Scenario
  - Total HI (RME and CTE) for child recreator exceeds target hazard level, total HI (RME) for adult recreator exceeds target hazard level.
  - Total ELCR (RME and CTE) within target risk range
  - COC for surface soil is 2,4,6-trinitrotoluene
  - Lead is a COC only for surface soil within the Catch Box Ruins
- Future Scenario
  - Total HI (RME) for child recreator exceeds target hazard level
  - Total HI (RME and CTE) for adult recreator and total HI (CTE) for child recreator do not exceed target hazard level
  - Total ELCR (RME and CTE) within target risk range
  - COC for soil is 2,4,6-trinitrotoluene
  - Lead is a COC only for soil within the Catch Box Ruins

### Construction Worker

- Exposure to surface and subsurface soil and groundwater under future scenarios
- Future Scenario only
  - Total HI (RME and CTE) exceeds target hazard level
  - Total ELCR (RME and CTE) within target risk range

- COC for soil is 2,4,6-trinitrotoluene

### Resident (Adult and Child)

- Exposure to surface and subsurface soil and groundwater under future scenarios
- Future Scenario only
  - Total HI (RME and CTE) exceeds target hazard level
  - Total ELCR (RME and CTE) exceeds target risk level
  - COCs for soil are 2,4,6-trinitrotoluene, 2-nitrotoluene, arsenic, and hexavalent chromium
  - Lead is a COC only for soil within the Catch Box Ruins
  - COCs for groundwater are arsenic and iron

To summarize, under current site use, 2,4,6-trinitrotoluene is a human health COC for surface soil and lead is a COC only for surface soil within the Catch Box Ruins area. For future unrestricted site use, 2,4,6-trinitrotoluene, 2-nitrotoluene, arsenic, and hexavalent chromium are human health COCs for soil, lead is COC only for Catch Box Ruins area soil, and arsenic and iron are human health COCs for groundwater.

The soil COC, 2-Nitrotoluene, was only detected in one of the thirty-nine soil samples and the detection limits for all the other soil samples were below the human health risk-based screening level. As there was only one detected concentration, this concentration was used as the exposure point concentration to estimate the hazards and risks associated with exposure to 2-nitrotoluene. Therefore, the risks associated with exposure to 2-nitrotoluene across the site are likely over-estimated.

The concentration of hexavalent chromium in subsurface soil exceeded the Residential soil RSL based on a carcinogenic risk of  $10^{-6}$ . However, this concentration would not exceed the Residential soil RSL adjusted to a carcinogenic risk of  $10^{-5}$  (3 mg/kg), indicating that the risk to a residential receptor would fall within the acceptable risk range of  $10^{-4}$  to  $10^{-6}$ . Therefore, it is unlikely there would be any adverse human health effects associated with exposure to hexavalent chromium in soil.

The detected concentrations of arsenic, a COC for groundwater, in the groundwater samples collected from the site-related monitoring wells were within the range of concentrations detected in the site-specific background monitoring wells. Therefore, the potential risks associated with exposure to arsenic in groundwater may be associated with background conditions.

## H.9 References

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TABLE H-1

## Summary of Data Used in Baseline Human Health Risk Assessment

## AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Medium/ Sample ID	Date of Sampling	Sample Locations	Parameters
Surface Soil			
CAA06-SS01-1008	10/20/2008	CAA06-SO01	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS02-1008	10/21/2008	CAA06-SO02	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS03-1008	10/21/2008	CAA06-SO03	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS04-1008	10/21/2008	CAA06-SO04	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS07-1108	11/5/2008	CAA06-SO07	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS08-1108	11/6/2008	CAA06-SO08	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS13-1108	11/6/2008	CAA06-SO13	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SS34-0913	9/17/2013	CAA06-MW01	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS35-0913	9/17/2013	CAA06-MW02	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS35P-0913 <sup>1</sup>	9/17/2013	CAA06-MW02	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS36-0913	9/17/2013	CAA06-MW03	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS37-0913	9/17/2013	CAA06-MW04	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS38-0913	9/17/2013	CAA06-MW05	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS26-0913	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS26P-0913 <sup>1</sup>	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS27-0913	9/18/2013	CAA06-SO27	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS28-0913	9/18/2013	CAA06-SO28	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS29-0913	9/18/2013	CAA06-SO29	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS30-0913	9/18/2013	CAA06-SO30	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS31-0913	9/18/2013	CAA06-SO31	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS32-0913	9/18/2013	CAA06-SO32	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS33-0913	9/18/2013	CAA06-SO33	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SS39-0913	9/17/2013	CAA06-SO39	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SO26-000H-0913	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
Subsurface Soil			
CAA06-SB01-1008	10/20/2008	CAA06-SO01	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB02-1008	10/21/2008	CAA06-SO02	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB03-1008	10/21/2008	CAA06-SO03	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB04-1008	10/21/2008	CAA06-SO04	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB07-1108	11/5/2008	CAA06-SO07	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB08-1108	11/6/2008	CAA06-SO08	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide
CAA06-SB13-1108	11/6/2008	CAA06-SO13	TCL SVOCs, explosives, nitroglycerin, nitroguanadine, TAL inorganics/cyanide

TABLE H-1

## Summary of Data Used in Baseline Human Health Risk Assessment

## AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Medium/ Sample ID	Date of Sampling	Sample Locations	Parameters
CAA06-SB26-0H02-0913	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB26P-0H02-0913 <sup>1</sup>	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB27-0H02-0913	9/18/2013	CAA06-SO27	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB28-0H02-0913	9/18/2013	CAA06-SO28	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB29-0H02-0913	9/18/2013	CAA06-SO29	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB30-0H02-0913	9/18/2013	CAA06-SO30	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB31-0H02-0913	9/18/2013	CAA06-SO31	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB32-0H02-0913	9/18/2013	CAA06-SO32	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB33-0H02-0913	9/18/2013	CAA06-SO33	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB34-0H02-0913	9/17/2013	CAA06-MW01	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB35-0H02-0913	9/17/2013	CAA06-MW02	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB35P-0H02-0913 <sup>1</sup>	9/17/2013	CAA06-MW02	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB36-0H02-0913	9/17/2013	CAA06-MW03	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB37-0H02-0913	9/17/2013	CAA06-MW04	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB38-0H02-0913	9/17/2013	CAA06-MW05	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SB39-0H02-0913	9/17/2013	CAA06-SO39	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
CAA06-SO26-0H02-0913	9/19/2013	CAA06-SO26	TCL SVOCs, explosives, nitroglycerin, TAL inorganics/cyanide, hexavalent chromium
<b>Groundwater</b>			
CAA06-GW02-1013	10/2/2013	CAA06-MW02	TAL inorganics/cyanide
CAA06-GW03-1013	10/2/2013	CAA06-MW03	TAL inorganics/cyanide
CAA06-GW04-1013	10/2/2013	CAA06-MW04	TAL inorganics/cyanide (total and dissolved)
CAA06-GW05-1013	10/2/2013	CAA06-MW05	TAL inorganics/cyanide (total and dissolved)
<b>Reference (Background) Groundwater</b>			
CAA06-GW01-1013	10/2/2013	CAA06-MW01	TAL inorganics/cyanide (total and dissolved)
CAA06-GW01P-1013 <sup>1</sup>	10/2/2013	CAA06-MW01	TAL inorganics/cyanide (total and dissolved)
CAA06-GW06-1013	10/2/2013	CAA06-MW06	TAL inorganics/cyanide (total and dissolved)

## Notes:

SVOCs = semivolatile organic compounds

TAL = target analyte list

TCL = target compound list

<sup>1</sup> Duplicate of previous sample.

TABLE H-2

## Summary of Chemicals of Potential Concern for the HHRA

*AOC 6 TNT Subareas - Remedial Investigation**Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

<b>Surface Soil</b>
2,4-Dinitrotoluene 1,3-Dinitrobenzene 2,4,6-Trinitrotoluene 2-Amino-4,6-dinitrotoluene 2-Nitrotoluene 4-Amino-2,6-dinitrotoluene Aluminum Arsenic Cobalt Iron Lead Thallium Vanadium
<b>Surface and Subsurface Soil</b>
2,4-Dinitrotoluene 1,3-Dinitrobenzene 2,4,6-Trinitrotoluene 2-Amino-4,6-dinitrotoluene 2-Nitrotoluene 4-Amino-2,6-dinitrotoluene Aluminum Arsenic Chromium (hexavalent) Cobalt Iron Lead Thallium Vanadium
<b>Groundwater</b>
Arsenic Cobalt Cyanide Iron Manganese

TABLE H-3

## Summary of RME Cancer Risks and Hazard Indices

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-5</sup> and <10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-6</sup> and <10 <sup>-5</sup>	Hazard Index	Chemicals with HI>1	COCs <sup>1</sup>
Current Base Worker	Surface Soil	Ingestion	6E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	10	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	9E-06			2,4,6-Trinitrotoluene	1		
		Inhalation	N/A				N/A		
		Total	7E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	12	2,4,6-Trinitrotoluene	
	All Media	Total	7E-05				12		
Current Recreational User Adult	Surface Soil	Ingestion	1E-05			2,4,6-Trinitrotoluene	2	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	2E-06				0.3		
		Inhalation	N/A				N/A		
		Total	1E-05			2,4,6-Trinitrotoluene	3	2,4,6-Trinitrotoluene	
	All Media	Total	1E-05				3		
Current Recreational User Child	Surface Soil	Ingestion	4E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene	25	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	3E-06			2,4,6-Trinitrotoluene	2	2,4,6-Trinitrotoluene	
		Inhalation	N/A				N/A		
		Total	4E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene	27	2,4,6-Trinitrotoluene	
	All Media	Total	4E-05				27		
Future Base Worker	Surface and Subsurface Soil	Ingestion	3E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	4	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	5E-06			2,4,6-Trinitrotoluene	0.6		
		Inhalation	N/A				N/A		
		Total	3E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	5	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	2E-04	Arsenic			2		Arsenic
		Dermal Contact	N/A				N/A		
		Inhalation	N/A				N/A		
		Total	2E-04	Arsenic			2		
	All Media	Total	2E-04				7		
Future Recreational User Adult	Surface and Subsurface Soil	Ingestion	5E-06			2,4,6-Trinitrotoluene	0.9		None
		Dermal Contact	9E-07				0.1		
		Inhalation	N/A				N/A		
		Total	6E-06			2,4,6-Trinitrotoluene	1		
	All Media	Total	6E-06				1		
Future Recreational User Child	Surface and Subsurface Soil	Ingestion	2E-05			2,4,6-Trinitrotoluene, 2-Nitrotoluene	10	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	2E-06				0.9		
		Inhalation	N/A				N/A		
		Total	2E-05			2,4,6-Trinitrotoluene, 2-Nitrotoluene, Arsenic	11	2,4,6-Trinitrotoluene	
	All Media	Total	2E-05				11		
Future Construction Worker	Surface and Subsurface Soil	Ingestion	2E-06			2,4,6-Trinitrotoluene	7	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	3E-07				0.7		
		Inhalation	N/A				N/A		
		Total	2E-06			2,4,6-Trinitrotoluene	8	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	N/A				N/A		None
		Dermal Contact	1E-07				0.1		
		Inhalation	N/A				N/A		
		Total	1E-07				0.1		
	All Media	Total	2E-06				8		

TABLE H-3

## Summary of RME Cancer Risks and Hazard Indices

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-5</sup> and <10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-6</sup> and <10 <sup>-5</sup>	Hazard Index	Chemicals with HI>1	COCs <sup>1</sup>
Future Resident Adult	Surface and Subsurface Soil	Ingestion	N/A				6	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	N/A				0.9		
		Inhalation	N/A				N/A		
		Total	N/A				7	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	N/A				6	Arsenic, Iron	Arsenic, Iron
		Dermal Contact	N/A				0.1		
		Inhalation	N/A				N/A		
		Total	N/A				6	Arsenic, Iron	
	All Media	Total	N/A				14		
Future Resident Child	Surface and Subsurface Soil	Ingestion	N/A				67	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	N/A				6	2,4,6-Trinitrotoluene	
		Inhalation	N/A				N/A		
		Total	N/A				73	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	N/A				10	Arsenic, Iron	Arsenic, Iron
		Dermal Contact	N/A				0.1		
		Inhalation	N/A				N/A		
		Total	N/A				11	Arsenic, Iron	
	All Media	Total	N/A				84		
Future Resident Child/Adult	Surface and Subsurface Soil	Ingestion	1E-04		2,4,6-Trinitrotoluene, 2-Nitrotoluene	Arsenic, Chromium (hexavalent)	N/A		2,4,6-Trinitrotoluene, 2-Nitrotoluene, Arsenic, Chromium (hexavalent)
		Dermal Contact	2E-05			2,4,6-Trinitrotoluene, 2-Nitrotoluene, Chromium (hexavalent)	N/A		
		Inhalation	N/A				N/A		
		Total	2E-04		2,4,6-Trinitrotoluene, 2-Nitrotoluene	Arsenic, Chromium (hexavalent)	N/A		
	Groundwater	Ingestion	6E-04	Arsenic			N/A		Arsenic
		Dermal Contact	3E-06			Arsenic	N/A		
		Inhalation	N/A				N/A		
		Total	6E-04	Arsenic			N/A		
	All Media	Total	8E-04				N/A		

## Notes:

<sup>1</sup> Includes analytes with an ELCR greater than 1E-06 that contribute to a total risk greater than 1E-04 and/or analytes with an HI greater than 0.1 that contribute to a target organ HI greater than 1.

COC = Contaminants of concern

ELCR = Excess Lifetime Cancer Risk

HI = Hazard Index

N/A = Not available/not applicable

TABLE H-4

## Summary of CTE Cancer Risks and Hazard Indices

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-5</sup> and <10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-6</sup> and <10 <sup>-5</sup>	Hazard Index	Chemicals with HI>1	COCs <sup>1</sup>
Current Base Worker	Surface Soil	Ingestion	1E-05			2,4,6-Trinitrotoluene	5	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	5E-07				0.2		
		Inhalation	N/A				N/A		
		Total	1E-05			2,4,6-Trinitrotoluene	5	2,4,6-Trinitrotoluene	
	All Media	Total	1E-05				5		
Current Recreational User Adult	Surface Soil	Ingestion	5E-07				0.2		None
		Dermal Contact	5E-08				0.02		
		Inhalation	N/A				N/A		
		Total	5E-07				0.3		
	All Media	Total	5E-07				0.3		
Current Recreational User Child	Surface Soil	Ingestion	4E-06			2,4,6-Trinitrotoluene	3	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	3E-07				0.2		
		Inhalation	N/A				N/A		
		Total	4E-06			2,4,6-Trinitrotoluene	3	2,4,6-Trinitrotoluene	
	All Media	Total	4E-06				3		
Future Base Worker	Surface and Subsurface Soil	Ingestion	5E-06			2,4,6-Trinitrotoluene	2	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	3E-07				0.09		
		Inhalation	N/A				N/A		
		Total	5E-06			2,4,6-Trinitrotoluene	2	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	2E-05		Arsenic		0.8		None
		Dermal Contact	N/A				N/A		
		Inhalation	N/A				N/A		
		Total	2E-05		Arsenic		0.8		
	All Media	Total	3E-05				3		
Future Recreational User Child	Surface and Subsurface Soil	Ingestion	2E-06				1		None
		Dermal Contact	2E-07				0.09		
		Inhalation	N/A				N/A		
		Total	2E-06			2,4,6-Trinitrotoluene	1		
	All Media	Total	2E-06				1		
Future Construction Worker	Surface and Subsurface Soil	Ingestion	6E-07				2	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	9E-08				0.2		
		Inhalation	N/A				N/A		
		Total	7E-07				2	2,4,6-Trinitrotoluene	
	All Media	Total	7E-07				2		
Future Resident Adult	Surface and Subsurface Soil	Ingestion	N/A				1		None
		Dermal Contact	N/A				0.1		
		Inhalation	N/A				N/A		
		Total	N/A				1		
	Groundwater	Ingestion	N/A				2		None
		Dermal Contact	N/A				0.04		
		Inhalation	N/A				N/A		
		Total	N/A				3		
	All Media	Total	N/A				4		

TABLE H-4

## Summary of CTE Cancer Risks and Hazard Indices

## AOC 6 TNT Subareas - Remedial Investigation

## Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$ and $<10^{-4}$	Chemicals with Cancer Risks $>10^{-6}$ and $<10^{-5}$	Hazard Index	Chemicals with HI>1	COCs <sup>1</sup>
Future Resident Child	Surface and Subsurface Soil	Ingestion	N/A				16	2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
		Dermal Contact	N/A				1		
		Inhalation	N/A				N/A		
		Total	N/A				17	2,4,6-Trinitrotoluene	
	Groundwater	Ingestion	N/A				4	Arsenic	Arsenic
		Dermal Contact	N/A				0.09		
		Inhalation	N/A				N/A		
		Total	N/A				4	Arsenic	
	All Media	Total	N/A				21		
Future Resident Child/Adult	Surface and Subsurface Soil	Ingestion	3E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	N/A		None
		Dermal Contact	3E-06			2,4,6-Trinitrotoluene	N/A		
		Inhalation	N/A				N/A		
		Total	3E-05		2,4,6-Trinitrotoluene	2-Nitrotoluene, Arsenic	N/A		
	Groundwater	Ingestion	2E-04	Arsenic			N/A		Arsenic
		Dermal Contact	1E-06				N/A		
		Inhalation	N/A				N/A		
		Total	2E-04	Arsenic			N/A		
	All Media	Total	2E-04				N/A		

## Notes:

<sup>1</sup> Includes analytes with an ELCR greater than 1E-06 that contribute to a total risk greater than 1E-04 and/or analytes with an HI greater than 0.1 that contribute to a target organ HI greater than 1.

COC = Contaminants of concern

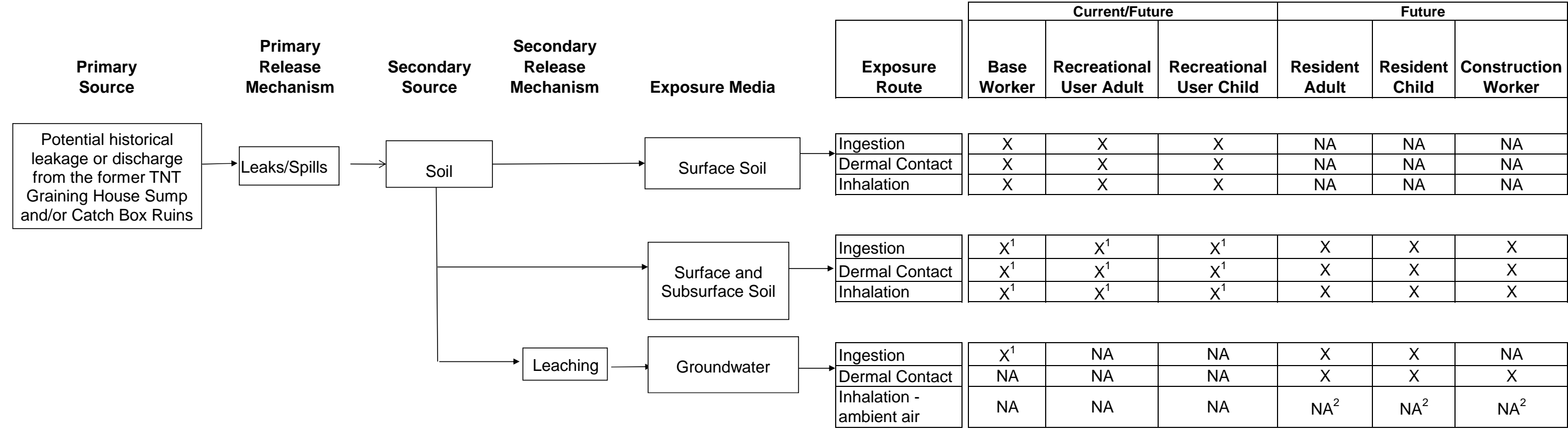
ELCR = Excess Lifetime Cancer Risk

HI = Hazard Index

N/A = Not available/not applicable

**Figure**

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**FIGURE H-1**  
Conceptual Site Model for HHRA  
AOC 6 TNT Subareas - Remedial Investigation  
Cheatham Annex Areas of Concern, Williamsburg, Virginia

NA - Not Applicable or pathway is incomplete  
X - Potentially complete exposure pathways  
<sup>1</sup> - Future exposure only.  
<sup>2</sup> - Volatile constituents are not associated with historic site use and were not included in groundwater analysis.

Appendix I  
Human Health Risk Assessment Tables

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TABLE 1  
SELECTION OF EXPOSURE PATHWAYS  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Surface Soil	Surface Soil	Surface Soil	Base Worker	Adult	Dermal	On-site	Quant	Base workers may contact AOC 6 surface soil during while performing maintenance activities.
						Ingestion	On-site	Quant	
				Recreational User	Adult	Dermal	On-site	Quant	Although access to site is restricted, recreational users may contact surface soil while on the site.
						Ingestion	On-site	Quant	
					Child	Dermal	On-site	Quant	Although access to site is restricted, recreational users may contact surface soil while on the site.
						Ingestion	On-site	Quant	
		Air	Emissions from Surface Soil	Base Worker	Adult	Inhalation	On-site	Quant	Base workers may inhale dust from AOC 6 surface soil while performing maintenance activities.
				Recreational User	Adult	Inhalation	On-site	Quant	Although access to site is restricted, recreational users may inhale dust emanating from surface soil while on the site.
Future	Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Base Worker	Adult	Dermal	On-site	Quant	If site is developed for future industrial use and soil is excavated and surface and subsurface soil mixed during site development, future base workers may contact soil while working at the site.
						Ingestion	On-site	Quant	
				Recreational User	Adult	Dermal	On-site	Quant	Recreational users could be exposed to surface and subsurface soil if soil excavated and surface and subsurface soil mix during development of the site.
						Ingestion	On-site	Quant	
					Child	Dermal	On-site	Quant	
						Ingestion	On-site	Quant	
				Construction Worker	Adult	Dermal	On-site	Quant	Construction workers could contact surface and subsurface soil during construction or excavation activities at the site.
						Ingestion	On-site	Quant	
				Resident*	Adult	Dermal	On-site	Quant	The site is not expected to be developed for residential use; however, the residential scenario is included for a conservative evaluation of unrestricted land use. Residents could be exposed to surface and subsurface soil if soil excavated and surface and subsurface soil mix during residential development of the site.
						Ingestion	On-site	Quant	
					Child	Dermal	On-site	Quant	
						Ingestion	On-site	Quant	
				Child/Adult		Dermal	On-site	Quant	
						Ingestion	On-site	Quant	
		Air	Emissions from Surface and Subsurface Soil	Base Worker	Adult	Inhalation	On-site	Quant	Base workers may inhale dust and vapors from soil while at site.
				Recreational User	Adult	Inhalation	On-site	Quant	Recreational users may inhale dust and vapors from soil while on site.
					Child	Inhalation	On-site	Quant	
				Construction Worker	Adult	Inhalation	On-site	Quant	Construction workers may inhale vapors and dust while performing construction activities.
				Resident*	Adult	Inhalation	On-site	Quant	The site is not expected to be developed for residential use; however, the residential scenario is included for a conservative evaluation of unrestricted land use. Future residents could inhale dust and vapors from
					Child	Inhalation	On-site	Quant	
					Child/Adult	Inhalation	On-site	Quant	

TABLE 1  
SELECTION OF EXPOSURE PATHWAYS  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (cont'd)	Groundwater	Groundwater	Tap Water	Base Worker	Adult	Dermal Absorption	On-site	None	Base workers assumed not to shower/bath at work.
						Ingestion	On-site	Quant	Groundwater is not currently used on-site as a water supply; however, although unlikely, future industrial potable use of the groundwater is possible.
				Resident*	Adult	Dermal Absorption	On-site	Quant	Groundwater is not currently used on-site as a water supply and the site is not expected to be developed for residential use; however, the residential scenario is included for a conservative evaluation of unrestricted land use.
						Ingestion	On-site	Quant	
					Child	Dermal Absorption	On-site	Quant	
						Ingestion	On-site	Quant	
					Child/Adult	Dermal Absorption	On-site	Quant	
						Ingestion	On-site	Quant	
			Water in Excavation Trench	Construction Worker	Adult	Dermal	On-site	Quant	Construction workers could be exposed to shallow groundwater during construction and excavation activities.
						Ingestion	On-site	None	Incidental ingestion of groundwater by construction workers would be minimal during construction or excavation activities.
		Air	Water Vapors at Showerhead	Base Worker	Adult	Inhalation	On-site	None	Historic site use not associated with significant VOC contamination and minimal VOCs were detected in previous investigations. Therefore, VOCs were not included in groundwater analysis.
				Resident*	Adult	Inhalation	On-site	None	Historic site use not associated with significant VOC contamination and minimal VOCs were detected in previous investigations. Therefore, VOCs were not included in groundwater analysis.
						Inhalation	On-site	None	Children are assumed not to shower.
					Child/Adult	Inhalation	On-site	None	Historic site use not associated with significant VOC contamination and minimal VOCs were detected in previous investigations. Therefore, VOCs were not included in groundwater analysis.
			Water Vapors at Excavation Trench	Construction Worker	Adult	Inhalation	On-site	None	Historic site use not associated with significant VOC contamination and minimal VOCs were detected in previous investigations. Therefore, VOCs were not included in groundwater analysis.

\* Noncarcinogenic hazard evaluated separately for adult and child receptors, combined lifetime carcinogenic risk evaluated on an age-adjusted basis for residential scenario.  
Quant: will be quantitatively evaluated.

Table 2.1  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	121-14-2	2,4-Dinitrotoluene	1.4E-01 J	6.3E+00 L	MG/KG	CAA06-SS01-1008	5/20	0.099 - 0.76	6.3E+00	N/A	1.7E+00 C	3.2E-04	SSL	YES	ASL
	606-20-2	2,6-Dinitrotoluene	3.1E-01 J	3.1E-01 J	MG/KG	CAA06-SO26-000H-0913	1/20	0.099 - 0.76	3.1E-01	N/A	3.6E-01 C	6.7E-05	SSL	NO	BSL
	100-52-7	Benzaldehyde	3.2E-01 J	3.2E-01 J	MG/KG	CAA06-SS01-1008	1/7	0.37 - 0.46	3.2E-01	N/A	7.8E+02 N	4.3E-02	SSL	NO	BSL
	56-55-3	Benzo(a)anthracene	1.1E-01 J	1.1E-01 J	MG/KG	CAA06-SS01-1008	1/7	0.37 - 0.46	1.1E-01	N/A	1.5E-01 C	1.2E-02	SSL	NO	BSL
	218-01-9	Chrysene	1.5E-01 J	1.5E-01 J	MG/KG	CAA06-SS01-1008	1/7	0.37 - 0.46	1.5E-01	N/A	1.5E+01 C	1.2E+00	SSL	NO	BSL
	206-44-0	Fluoranthene	3.0E-01 J	3.0E-01 J	MG/KG	CAA06-SS01-1008	1/7	0.37 - 0.46	3.0E-01	N/A	2.3E+02 N	8.9E+00	SSL	NO	BSL
	129-00-0	Pyrene	5.8E-01 J	5.8E-01 J	MG/KG	CAA06-SS01-1008	1/7	0.37 - 0.46	5.8E-01	N/A	1.7E+02 N	1.3E+00	SSL	NO	BSL
	99-35-4	1,3,5-Trinitrobenzene	2.5E-01	2.0E+01	MG/KG	CAA06-SO26-000H-0913	5/20	0.099 - 0.76	2.0E+01	N/A	2.2E+02 N	2.1E-01	SSL	NO	BSL
	99-65-0	1,3-Dinitrobenzene	8.4E-02 J	2.5E+00	MG/KG	CAA06-SO26-000H-0913	4/20	0.099 - 0.76	2.5E+00	N/A	6.2E-01 N	1.8E-04	SSL	YES	ASL
	118-96-7	2,4,6-Trinitrotoluene	1.7E-01	1.4E+04	MG/KG	CAA06-SO26-000H-0913	10/20	0.099 - 5200	1.4E+04	N/A	3.6E+00 N	5.7E-03	SSL	YES	ASL
	35572-78-2	2-Amino-4,6-dinitrotoluene	8.7E-01	1.6E+01 J	MG/KG	CAA06-SS02-1008	6/20	0.099 - 0.76	1.6E+01	N/A	1.5E+01 N	3.0E-03	SSL	YES	ASL
	88-72-2	2-Nitrotoluene	4.8E+01 J	4.8E+01 J	MG/KG	CAA06-SS02-1008	1/19	0.2 - 0.76	4.8E+01	N/A	3.2E+00 C	2.9E-04	SSL	YES	ASL
	618-87-1	3,5-Dinitroaniline	8.9E-01	1.6E+00	MG/KG	CAA06-SO26-000H-0913	2/20	0.099 - 0.76	1.6E+00	N/A	N/A	N/A	N/A	NO	NTX
	19406-51-0	4-Amino-2,6-dinitrotoluene	7.1E-01	1.7E+01	MG/KG	CAA06-SS02-1008	7/19	0.099 - 0.76	1.7E+01	N/A	1.5E+01 N	3.0E-03	SSL	YES	ASL
	121-82-4	RDX	2.2E-01	3.8E-01 J	MG/KG	CAA06-SO26-000H-0913	2/20	0.2 - 0.76	3.8E-01	N/A	6.0E+00 C	2.7E-04	SSL	NO	BSL
	479-45-8	Tetryl	6.4E-01	6.4E-01	MG/KG	CAA06-SS01-1008	1/20	0.2 - 0.76	6.4E-01	N/A	1.2E+01 N	3.7E-02	SSL	NO	BSL
	7429-90-5	Aluminum	2.7E+03	2.5E+04	MG/KG	CAA06-SS03-1008	20/20	9.3 - 190	2.5E+04	1.2E+04	7.7E+03 N	3.0E+03	SSL	YES	ASL
	7440-36-0	Antimony	8.9E-02 J	6.2E-01	MG/KG	CAA06-SS38-0913	11/20	0.092 - 14	6.2E-01	1.1E+01	3.1E+00 N	3.5E-02	SSL	NO	BSL
	7440-38-2	Arsenic	1.1E+00	1.2E+01 J	MG/KG	CAA06-SS03-1008	20/20	0.091 - 2.3	1.2E+01	6.4E+00	6.7E-01 C	1.5E-03	SSL	YES	ASL
	7440-39-3	Barium	9.4E+00	4.6E+01	MG/KG	CAA06-SS03-1008	20/20	0.1 - 25	4.6E+01	5.3E+01	1.5E+03 N	1.6E+01	SSL	NO	BSL
	7440-41-7	Beryllium	9.2E-02 J	5.8E-01	MG/KG	CAA06-SS28-0913	20/20	0.091 - 0.62	5.8E-01	5.9E-01	1.6E+01 N	1.9E+00	SSL	NO	BSL
	7440-43-9	Cadmium	1.7E-02 J	2.9E-01	MG/KG	CAA06-SO26-000H-0913	17/20	0.046 - 1.1	2.9E-01	1.5E+00	7.0E+00 N	N/A	N/A	NO	BSL
	7440-70-2	Calcium	6.1E+01	4.0E+03	MG/KG	CAA06-SO26-000H-0913	20/20	47 - 620	4.0E+03	2.3E+03	N/A	N/A	N/A	NO	NUT
	7440-47-3	Chromium	3.6E+00	3.5E+01 L	MG/KG	CAA06-SS03-1008	22/22	0.092 - 2.3	3.5E+01	1.8E+01	1.2E+04 N	4.0E+06	SSL	NO	BSL
	7440-48-4	Cobalt	5.7E-01	3.6E+00 J	MG/KG	CAA06-SS01-1008	20/20	0.091 - 11	3.6E+00	9.9E+00	2.3E+00 N	2.7E-02	SSL	YES	ASL
	7440-50-8	Copper	1.2E+00	1.3E+01 K	MG/KG	CAA06-SS36-0913	17/20	0.091 - 3.1	1.3E+01	4.3E+00	3.1E+02 N	2.8E+00	SSL	NO	BSL
	57-12-5	Cyanide	4.7E-02 J	1.3E+00	MG/KG	CAA06-SS13-1108	10/20	0.11 - 0.7	1.3E+00	N/A	2.1E+00 N	1.5E-03	SSL	NO	BSL
	7439-89-6	Iron	3.8E+03	3.8E+04	MG/KG	CAA06-SO26-000H-0913	20/20	4.7 - 940	3.8E+04	2.0E+04	5.5E+03 N	3.5E+01	SSL	YES	ASL
	7439-92-1	Lead	9.9E+00 J	1.1E+03	MG/KG	CAA06-SO26-000H-0913	20/20	0.46 - 20	1.1E+03	1.7E+01	4.0E+02 L	N/A	N/A	YES	ASL
	7439-95-4	Magnesium	2.0E+02	1.3E+03	MG/KG	CAA06-SS03-1008	20/20	47 - 1100	1.3E+03	1.1E+03	N/A	N/A	N/A	NO	NUT
	7439-96-5	Manganese	1.2E+01	1.8E+02	MG/KG	CAA06-SS01-1008	20/20	0.46 - 3.4	1.8E+02	3.2E+02	1.8E+02 N	N/A	N/A	NO	BSL
	7439-97-6	Mercury	4.6E-02 J	1.3E-01	MG/KG	CAA06-SO26-000H-0913 : CAA06-SS01-1008	15/20	0.047 - 0.15	1.3E-01	1.1E-01	2.3E+00 N	N/A	N/A	NO	BSL
	7440-02-0	Nickel	1.6E+00	1.0E+01	MG/KG	CAA06-SS01-1008	20/20	0.091 - 9.1	1.0E+01	9.5E+00	1.5E+02 N	2.6E+00	SSL	NO	BSL
	7440-09-7	Potassium	1.8E+02	1.5E+03	MG/KG	CAA06-SS03-1008	20/20	47 - 620	1.5E+03	7.1E+02	N/A	N/A	N/A	NO	NUT
	7782-49-2	Selenium	4.9E-02 J	2.0E+00 J	MG/KG	CAA06-SS01-1008	14/20	0.091 - 8	2.0E+00	5.1E-01	3.9E+01 N	5.2E-02	SSL	NO	BSL
	7440-22-4	Silver	1.7E-02 J	5.5E-02	MG/KG	CAA06-SS38-0913	13/20	0.046 - 2.3	5.5E-02	2.1E+00	3.9E+01 N	8.0E-02	SSL	NO	BSL

Table 2.1  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil (con't)	7440-23-5	Sodium	8.7E+00 J	6.8E+01 J	MG/KG	CAA06-SS01-1008	11/20	47 - 620	6.8E+01	5.2E+02	N/A	N/A	N/A	NO	NUT
	7440-28-0	Thallium	5.8E-02	1.8E-01 J	MG/KG	CAA06-SS03-1008	14/20	0.046 - 5.7	1.8E-01	N/A	7.8E-02 N	1.4E-03	SSL	YES	ASL
	7440-62-2	Vanadium	7.6E+00	5.0E+01	MG/KG	CAA06-SS03-1008	20/20	0.93 - 11	5.0E+01	2.8E+01	3.9E+01 N	8.6E+00	SSL	YES	ASL
	7440-66-6	Zinc	7.1E+00	1.8E+02	MG/KG	CAA06-SS03-1008	17/20	1 - 25	1.8E+02	2.7E+01	2.3E+03 N	3.7E+01	SSL	NO	BSL

- [1] Minimum/Maximum detected concentrations.
- [2] Maximum concentration is used for screening.
- [3] Background values are 95% UTL from Cheatham Annex/Yorktown background surface soil samples, June 2012.
- [4] Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential soil RSLs. [Online]. Available: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)  
RSL based on noncarcinogenic endpoints based on hazard quotient of 0.1. RSL based on carcinogenic endpoints based on cancer risk of 10-6.  
RSL value for chromium (III) insoluble salts used for chromium because hexavalent chromium was also analyzed in the soil samples but not detected.  
RSL value for mercuric chloride (and other mercury salts) used for mercury.
- [5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)  
Deletion Reason: No Toxicity Information (NTX)  
Essential Nutrient (NUT)  
Below Screening Level (BSL)

COPC = Chemical of Potential Concern  
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
To Be Considered  
J = Estimated Value  
K = Biased High  
L = Biased Low  
C = Carcinogenic  
N = Noncarcinogenic  
MG/KG = milligrams per kilogram  
N/A = Not available  
SSL = Risk Based Soil Screening Levels from RSL table (noncarcinogenic  
endpoints based on hazard quotient of 0.1)  
NL = Noncarcinogenic lead residential soil RSL based on IEUBK model.

Table 2.2  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Emissions from Surface Soil	121-14-2	2,4-Dinitrotoluene	1.0E-07 J	4.6E-06 L	ug/m <sup>3</sup>	CAA06-SS01-1008	5/20	N/A	4.6E-06	N/A	3.2E-02 C	N/A	N/A	NO	BSL
	606-20-2	2,6-Dinitrotoluene	2.3E-07 J	2.3E-07 J	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	1/20	N/A	2.3E-07	N/A	N/A	N/A	N/A	NO	NTX
	100-52-7	Benzaldehyde	1.1E-02 J	1.1E-02 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/7	N/A	1.1E-02	N/A	N/A	N/A	N/A	NO	NTX
	56-55-3	Benzo(a)anthracene	8.1E-08 J	8.1E-08 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/7	N/A	8.1E-08	N/A	9.2E-03 C	N/A	N/A	NO	BSL
	218-01-9	Chrysene	1.1E-07 J	1.1E-07 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/7	N/A	1.1E-07	N/A	9.2E-02 C	N/A	N/A	NO	BSL
	206-44-0	Fluoranthene	2.2E-07 J	2.2E-07 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/7	N/A	2.2E-07	N/A	N/A	N/A	N/A	NO	NTX
	129-00-0	Pyrene	1.9E-04 J	1.9E-04 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/7	N/A	1.9E-04	N/A	N/A	N/A	N/A	NO	NTX
	99-35-4	1,3,5-Trinitrobenzene	1.8E-07	1.5E-05	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	5/20	N/A	1.5E-05	N/A	N/A	N/A	N/A	NO	NTX
	99-65-0	1,3-Dinitrobenzene	6.2E-08 J	1.8E-06	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	4/20	N/A	1.8E-06	N/A	N/A	N/A	N/A	NO	NTX
	118-96-7	2,4,6-Trinitrotoluene	1.3E-07	1.0E-02	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	10/20	N/A	1.0E-02	N/A	N/A	N/A	N/A	NO	NTX
	35572-78-2	2-Amino-4,6-dinitrotoluene	6.4E-07	1.2E-05 J	ug/m <sup>3</sup>	CAA06-SS02-1008	6/20	N/A	1.2E-05	N/A	N/A	N/A	N/A	NO	NTX
	88-72-2	2-Nitrotoluene	2.7E-01 J	2.7E-01 J	ug/m <sup>3</sup>	CAA06-SS02-1008	1/19	N/A	2.7E-01	N/A	N/A	N/A	N/A	NO	NTX
	618-87-1	3,5-Dinitroaniline	6.5E-07	1.2E-06	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	2/20	N/A	1.2E-06	N/A	N/A	N/A	N/A	NO	NTX
	19406-51-0	4-Amino-2,6-dinitrotoluene	5.2E-07	1.3E-05	ug/m <sup>3</sup>	CAA06-SS02-1008	7/19	N/A	1.3E-05	N/A	N/A	N/A	N/A	NO	NTX
	121-82-4	RDX	1.6E-07	2.8E-07 J	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	2/20	N/A	2.8E-07	N/A	N/A	N/A	N/A	NO	NTX
	479-45-8	Tetryl	4.7E-07	4.7E-07	ug/m <sup>3</sup>	CAA06-SS01-1008	1/20	N/A	4.7E-07	N/A	N/A	N/A	N/A	NO	NTX
	7429-90-5	Aluminum	2.0E-03	1.8E-02	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	1.8E-02	N/A	5.2E-01 N	N/A	N/A	NO	BSL
	7440-36-0	Antimony	6.5E-08 J	4.6E-07	ug/m <sup>3</sup>	CAA06-SS38-0913	11/20	N/A	4.6E-07	N/A	N/A	N/A	N/A	NO	NTX
	7440-38-2	Arsenic	8.1E-07	8.7E-06 J	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	8.7E-06	N/A	6.5E-04 C	N/A	N/A	NO	BSL
	7440-39-3	Barium	6.9E-06	3.4E-05	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	3.4E-05	N/A	5.2E-02 N	N/A	N/A	NO	BSL
	7440-41-7	Beryllium	6.8E-08 J	4.3E-07	ug/m <sup>3</sup>	CAA06-SS28-0913	20/20	N/A	4.3E-07	N/A	1.2E-03 C	N/A	N/A	NO	BSL
	7440-43-9	Cadmium	1.3E-08 J	2.1E-07	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	17/20	N/A	2.1E-07	N/A	1.0E-03 N	N/A	N/A	NO	BSL
	7440-70-2	Calcium	4.5E-05	2.9E-03	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	20/20	N/A	2.9E-03	N/A	N/A	N/A	N/A	NO	NUT
	7440-47-3	Chromium	2.6E-06	2.6E-05 L	ug/m <sup>3</sup>	CAA06-SS03-1008	22/22	N/A	2.6E-05	N/A	N/A	N/A	N/A	NO	NTX
	7440-48-4	Cobalt	4.2E-07	2.6E-06 J	ug/m <sup>3</sup>	CAA06-SS01-1008	20/20	N/A	2.6E-06	N/A	3.1E-04 C	N/A	N/A	NO	BSL
	7440-50-8	Copper	8.8E-07	9.6E-06 K	ug/m <sup>3</sup>	CAA06-SS36-0913	17/20	N/A	9.6E-06	N/A	N/A	N/A	N/A	NO	NTX
	57-12-5	Cyanide	3.5E-08 J	9.6E-07	ug/m <sup>3</sup>	CAA06-SS13-1108	10/20	N/A	9.6E-07	N/A	8.3E-02 N	N/A	N/A	NO	BSL
	7439-89-6	Iron	2.8E-03	2.8E-02	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	20/20	N/A	2.8E-02	N/A	N/A	N/A	N/A	NO	NTX
	7439-92-1	Lead	7.3E-06 J	8.1E-04	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	20/20	N/A	8.1E-04	N/A	1.5E-01 N	N/A	N/A	NO	BSL
	7439-95-4	Magnesium	1.5E-04	9.3E-04	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	9.3E-04	N/A	N/A	N/A	N/A	NO	NUT
	7439-96-5	Manganese	8.8E-06	1.3E-04	ug/m <sup>3</sup>	CAA06-SS01-1008	20/20	N/A	1.3E-04	N/A	5.2E-03 N	N/A	N/A	NO	BSL
	7439-97-6	Mercury	3.4E-08 J	9.6E-08	ug/m <sup>3</sup>	CAA06-SO26-000H-0913 : CAA06-SS01-1008	15/20	N/A	9.6E-08	N/A	3.1E-02 N	N/A	N/A	NO	BSL
	7440-02-0	Nickel	1.2E-06	7.4E-06	ug/m <sup>3</sup>	CAA06-SS01-1008	20/20	N/A	7.4E-06	N/A	9.4E-03 N	N/A	N/A	NO	BSL
	7440-09-7	Potassium	1.3E-04	1.1E-03	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	1.1E-03	N/A	N/A	N/A	N/A	NO	NUT
	7782-49-2	Selenium	3.6E-08 J	1.5E-06 J	ug/m <sup>3</sup>	CAA06-SS01-1008	14/20	N/A	1.5E-06	N/A	2.1E+00 N	N/A	N/A	NO	BSL

Table 2.2  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Emissions from Surface Soil (cont'd)	7440-22-4	Silver	1.3E-08 J	4.0E-08	ug/m <sup>3</sup>	CAA06-SS38-0913	13/20	N/A	4.0E-08	N/A	N/A	N/A	N/A	NO	NTX
	7440-23-5	Sodium	6.4E-06 J	5.0E-05 J	ug/m <sup>3</sup>	CAA06-SS01-1008	11/20	N/A	5.0E-05	N/A	N/A	N/A	N/A	NO	NUT
	7440-28-0	Thallium	4.3E-08	1.3E-07 J	ug/m <sup>3</sup>	CAA06-SS03-1008	14/20	N/A	1.3E-07	N/A	N/A	N/A	N/A	NO	NTX
	7440-62-2	Vanadium	5.6E-06	3.7E-05	ug/m <sup>3</sup>	CAA06-SS03-1008	20/20	N/A	3.7E-05	N/A	1.0E-02 N	N/A	N/A	NO	BSL
	7440-66-6	Zinc	5.2E-06	1.3E-04	ug/m <sup>3</sup>	CAA06-SS03-1008	17/20	N/A	1.3E-04	N/A	N/A	N/A	N/A	NO	NTX

[1] Minimum/Maximum calculated air concentrations from surface soil concentrations. Air concentrations calculated as  $C_{air} = C_{soil} * 1000 * (1/PEF + 1/VF)$ .  
PEF = 1.36E+09 m3/kg. VF calculated for volatile constituents only, on Table 2.2A. PEF and VF from USEPA's Soil Screening Guidance. (USEPA, 2002)

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential air RSLs.  
[Online]. Available: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)

RSL based on noncarcinogenic endpoints based on hazard quotient of 0.1. RSL based on carcinogenic endpoints based on cancer risk of 10-6.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)  
Deletion Reason: No Toxicity Information (NTX)  
Essential Nutrient (NUT)  
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

C = Carcinogenic

N = Noncarcinogenic

ug/m<sup>3</sup> = micrograms per cubic meter

N/A = Not available

Table 2.2A  
Calculation of Volatilization Factor - Surface Soil, Surface and Subsurface Soil  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Diffusivity in Air (D <sub>i</sub> ) (cm <sup>2</sup> /s)	Henry's Law Constant (H')	Diffusivity in Water (D <sub>w</sub> ) (cm <sup>2</sup> /s)	Soil Organic Carbon Partition Coeff. (K <sub>oc</sub> ) (cm <sup>3</sup> /g)	Soil Water Partition Coeff. (K <sub>d</sub> = K <sub>oc</sub> x F <sub>oc</sub> ) (g/cm <sup>3</sup> )	Solubility in Water (S) (mg/L)	Apparent Diffusivity (D <sub>A</sub> ) (cm <sup>2</sup> /s)	Volatilization Factor (VF) (m <sup>3</sup> /kg)
Benzaldehyde	7.4E-02	1.1E-03	9.5E-06	1.1E+01	6.7E-02	7.0E+03	2.6E-05	2.9E+04
Pyrene	2.8E-02	4.9E-04	7.2E-06	5.4E+04	3.3E+02	1.4E-01	2.3E-09	3.1E+06
2-Nitrotoluene	5.9E-02	5.1E-04	8.7E-06	3.7E+02	2.2E+00	6.5E+02	7.1E-07	1.8E+05
Volatilization factor (VF) = <div><div>(m<sup>3</sup>/kg)</div><div><math display="block">\frac{Q/C * (3.14 * D_A * T)^{1/2} * 10^{-4} \text{ m}^2/\text{cm}^2}{2 * r_b * D_A}</math></div></div>								
Apparent Diffusivity (D <sub>A</sub> ) = <div><div>(cm<sup>2</sup>/s)</div><div><math display="block">\frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}</math></div></div>								
Parameters				Values				
Q/Cvol - Inverse of the geometric mean air concentration t of a 0.5-acre-square source (Harrisburg, PA) (g/m2-s per kg/m3)				81.9				
T - Exposure interval(s)				9.5E+08				
r <sub>b</sub> - Soil bulk density (g/cm <sup>3</sup> )				1.5				
Q <sub>a</sub> - Air-filled soil porosity (L <sub>air</sub> /L <sub>water</sub> ) = n - Q <sub>w</sub>				0.28				
n - Total soil porosity (L <sub>pore</sub> /L <sub>soil</sub> ) = 1 - (r <sub>b</sub> /r <sub>s</sub> )				0.43				
Q <sub>w</sub> - Water-filled soil porosity (L <sub>water</sub> /L <sub>soil</sub> )				0.15				
r <sub>s</sub> - Soil particle density (g/cm <sup>3</sup> )				2.65				
f <sub>oc</sub> - fraction organic carbon in soil (g/g)				0.006				

Equations from USEPA, 1996. *Soil Screening Guidance: User's Guide*. EPA/540/R-96/018.

Physical/chemical properties from Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites.

Table 2.3  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface and Subsurface Soil	121-14-2	2,4-Dinitrotoluene	1.4E-01 J	1.2E+01	MG/KG	CAA06-SO26-0H02-0913	9/40	0.099 - 0.76	1.2E+01	N/A	1.7E+00 C	3.2E-04	SSL	YES	ASL
	606-20-2	2,6-Dinitrotoluene	3.1E-01 J	3.1E-01 J	MG/KG	CAA06-SO26-000H-0913	1/40	0.099 - 0.76	3.1E-01	N/A	3.6E-01 C	6.7E-05	SSL	NO	BSL
	100-52-7	Benzaldehyde	3.2E-01 J	3.2E-01 J	MG/KG	CAA06-SS01-1008	1/14	0.36 - 0.46	3.2E-01	N/A	7.8E+02 N	4.3E-02	SSL	NO	BSL
	56-55-3	Benzo(a)anthracene	1.1E-01 J	1.1E-01 J	MG/KG	CAA06-SS01-1008	1/14	0.36 - 0.46	1.1E-01	N/A	1.5E-01 C	1.2E-02	SSL	NO	BSL
	218-01-9	Chrysene	1.5E-01 J	1.5E-01 J	MG/KG	CAA06-SS01-1008	1/14	0.36 - 0.46	1.5E-01	N/A	1.5E+01 C	1.2E+00	SSL	NO	BSL
	206-44-0	Fluoranthene	3.0E-01 J	3.0E-01 J	MG/KG	CAA06-SS01-1008	1/14	0.36 - 0.46	3.0E-01	N/A	2.3E+02 N	8.9E+00	SSL	NO	BSL
	129-00-0	Pyrene	5.8E-01 J	5.8E-01 J	MG/KG	CAA06-SS01-1008	1/14	0.36 - 0.46	5.8E-01	N/A	1.7E+02 N	1.3E+00	SSL	NO	BSL
	99-35-4	1,3,5-Trinitrobenzene	2.5E-01	2.0E+01	MG/KG	CAA06-SO26-000H-0913	6/40	0.099 - 0.76	2.0E+01	N/A	2.2E+02 N	2.1E-01	SSL	NO	BSL
	99-65-0	1,3-Dinitrobenzene	2.8E-02 J	2.5E+00	MG/KG	CAA06-SO26-000H-0913	8/40	0.099 - 0.76	2.5E+00	N/A	6.2E-01 N	1.8E-04	SSL	YES	ASL
	118-96-7	2,4,6-Trinitrotoluene	1.7E-01	1.4E+04	MG/KG	CAA06-SO26-000H-0913	18/40	0.099 - 5400	1.4E+04	N/A	3.6E+00 N	5.7E-03	SSL	YES	ASL
	35572-78-2	2-Amino-4,6-dinitrotoluene	6.1E-01 J	1.6E+01 J	MG/KG	CAA06-SS02-1008	13/40	0.099 - 0.76	1.6E+01	N/A	1.5E+01 N	3.0E-03	SSL	YES	ASL
	88-72-2	2-Nitrotoluene	4.8E+01 J	4.8E+01 J	MG/KG	CAA06-SS02-1008	1/39	0.2 - 0.76	4.8E+01	N/A	3.2E+00 C	2.9E-04	SSL	YES	ASL
	618-87-1	3,5-Dinitroaniline	5.5E-01	1.6E+00	MG/KG	CAA06-SO26-000H-0913	3/40	0.099 - 0.76	1.6E+00	N/A	N/A	N/A	N/A	NO	NTX
	19406-51-0	4-Amino-2,6-dinitrotoluene	3.4E-01	3.0E+01	MG/KG	CAA06-SB13-1108	13/39	0.099 - 0.76	3.0E+01	N/A	1.5E+01 N	3.0E-03	SSL	YES	ASL
	99-99-0	4-Nitrotoluene	3.2E+00	3.2E+00	MG/KG	CAA06-SB36-0H02-0913	1/39	0.2 - 0.76	3.2E+00	N/A	2.5E+01 N	3.9E-03	SSL	NO	BSL
	121-82-4	RDX	2.2E-01	3.8E-01 J	MG/KG	CAA06-SO26-000H-0913	2/40	0.2 - 0.76	3.8E-01	N/A	6.0E+00 C	2.7E-04	SSL	NO	BSL
	479-45-8	Tetryl	6.4E-01	6.4E-01	MG/KG	CAA06-SS01-1008	1/40	0.2 - 0.76	6.4E-01	N/A	1.2E+01 N	3.7E-02	SSL	NO	BSL
	7429-90-5	Aluminum	2.7E+03	2.5E+04	MG/KG	CAA06-SS03-1008	40/40	9.3 - 250	2.5E+04	1.2E+04	7.7E+03 N	3.0E+03	SSL	YES	ASL
	7440-36-0	Antimony	8.8E-02 J	7.2E-01	MG/KG	CAA06-SB38-0H02-0913	19/40	0.091 - 14	7.2E-01	1.1E+01	3.1E+00 N	3.5E-02	SSL	NO	BSL
	7440-38-2	Arsenic	1.1E+00	2.1E+01 J	MG/KG	CAA06-SB01-1008	40/40	0.091 - 2.3	2.1E+01	5.5E+00	6.7E-01 C	1.5E-03	SSL	YES	ASL
	7440-39-3	Barium	9.4E+00	4.6E+01	MG/KG	CAA06-SS03-1008	40/40	0.1 - 25	4.6E+01	5.3E+01	1.5E+03 N	1.6E+01	SSL	NO	BSL
	7440-41-7	Beryllium	9.2E-02 J	7.3E-01	MG/KG	CAA06-SB01-1008	40/40	0.091 - 0.62	7.3E-01	5.2E-01	1.6E+01 N	1.9E+00	SSL	NO	BSL
	7440-43-9	Cadmium	1.3E-02 J	2.9E-01	MG/KG	CAA06-SO26-000H-0913	32/40	0.046 - 1.1	2.9E-01	1.5E+00	7.0E+00 N	N/A	N/A	NO	BSL
	7440-70-2	Calcium	6.1E+01	4.0E+03	MG/KG	CAA06-SO26-000H-0913	40/40	47 - 620	4.0E+03	2.3E+03	N/A	N/A	N/A	NO	NUT
	18540-29-9	Chromium (hexavalent)	3.1E-01 J	9.4E-01	MG/KG	CAA06-SB27-0H02-0913	2/4	0.45 - 0.59	9.4E-01	N/A	3.0E-01 C	6.7E-04	SSL	YES	ASL
	7440-47-3	Chromium	3.6E+00	3.6E+01 L	MG/KG	CAA06-SB03-1008	44/44	0.092 - 2.3	3.6E+01	1.8E+01	1.2E+04 N	4.0E+06	SSL	NO	BSL
	7440-48-4	Cobalt	5.7E-01	5.0E+00 J	MG/KG	CAA06-SB03-1008	40/40	0.091 - 11	5.0E+00	5.2E+00	2.3E+00 N	2.7E-02	SSL	YES	ASL
	7440-50-8	Copper	7.9E-01	1.3E+01 K	MG/KG	CAA06-SS36-0913	34/40	0.091 - 3.1	1.3E+01	3.2E+00	3.1E+02 N	2.8E+00	SSL	NO	BSL
	57-12-5	Cyanide	3.5E-02 J	1.3E+00	MG/KG	CAA06-SS13-1108	16/40	0.1 - 0.7	1.3E+00	2.7E+00	2.1E+00 N	1.5E-03	SSL	NO	BSL
	7439-89-6	Iron	3.5E+03	3.8E+04	MG/KG	CAA06-SO26-000H-0913	40/40	4.7 - 1200	3.8E+04	2.0E+04	5.5E+03 N	3.5E+01	SSL	YES	ASL
	7439-92-1	Lead	4.0E+00	1.1E+03	MG/KG	CAA06-SO26-000H-0913	40/40	0.094 - 20	1.1E+03	8.8E+00	4.0E+02 L	N/A	N/A	YES	ASL
	7439-95-4	Magnesium	2.0E+02	1.4E+03	MG/KG	CAA06-SB03-1008	40/40	47 - 1100	1.4E+03	1.1E+03	N/A	N/A	N/A	NO	NUT
	7439-96-5	Manganese	1.2E+01	1.8E+02	MG/KG	CAA06-SS01-1008	40/40	0.46 - 3.4	1.8E+02	1.8E+02	1.8E+02 N	N/A	N/A	NO	BSL
	7439-97-6	Mercury	3.4E-02 J	1.3E-01	MG/KG	CAA06-SO26-000H-0913 : CAA06-SS01-1008	26/40	0.046 - 0.15	1.3E-01	1.1E-01	2.3E+00 N	N/A	N/A	NO	BSL
	7440-02-0	Nickel	1.6E+00	1.7E+01	MG/KG	CAA06-SB03-1008	40/40	0.091 - 9.1	1.7E+01	9.5E+00	1.5E+02 N	2.6E+00	SSL	NO	BSL
	7440-09-7	Potassium	1.8E+02	1.6E+03	MG/KG	CAA06-SB03-1008	40/40	47 - 620	1.6E+03	7.1E+02	N/A	N/A	N/A	NO	NUT
	7782-49-2	Selenium	4.9E-02 J	2.0E+00 J	MG/KG	CAA06-SS01-1008	31/40	0.091 - 8	2.0E+00	5.1E-01	3.9E+01 N	5.2E-02	SSL	NO	BSL

Table 2.3  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface and Subsurface Soil (con't)	7440-22-4	Silver	1.1E-02 J	5.5E-02	MG/KG	CAA06-SS38-0913	26/40	0.046 - 2.3	5.5E-02	1.1E+00	3.9E+01 N	8.0E-02	SSL	NO	BSL
	7440-23-5	Sodium	8.7E+00 J	6.8E+01 J	MG/KG	CAA06-SS01-1008	22/40	47 - 620	6.8E+01	5.2E+02	N/A	N/A	N/A	NO	NUT
	<b>7440-28-0</b>	<b>Thallium</b>	<b>5.4E-02</b>	<b>1.8E-01 J</b>	<b>MG/KG</b>	<b>CAA06-SS03-1008</b>	<b>28/40</b>	<b>0.046 - 5.7</b>	<b>1.8E-01</b>	<b>N/A</b>	<b>7.8E-02 N</b>	<b>1.4E-03</b>	<b>SSL</b>	<b>YES</b>	<b>ASL</b>
	<b>7440-62-2</b>	<b>Vanadium</b>	<b>6.4E+00</b>	<b>5.4E+01</b>	<b>MG/KG</b>	<b>CAA06-SB03-1008</b>	<b>40/40</b>	<b>0.93 - 11</b>	<b>5.4E+01</b>	<b>2.8E+01</b>	<b>3.9E+01 N</b>	<b>8.6E+00</b>	<b>SSL</b>	<b>YES</b>	<b>ASL</b>
	7440-66-6	Zinc	7.1E+00	1.8E+02	MG/KG	CAA06-SS03-1008	35/40	1 - 25	1.8E+02	2.7E+01	2.3E+03 N	3.7E+01	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.  
[2] Maximum concentration is used for screening.  
[3] Background values are the lower of surface and subsurface 95% UTL from Cheatham Annex/Yorktown background samples, June 2012.  
[4] Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential soil RSLs. [Online]. Available: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)  
RSL based on noncarcinogenic endpoints based on hazard quotient of 0.1. RSL based on carcinogenic endpoints based on cancer risk of 10-6.  
RSL value for chromium (III) insoluble salts used for chromium.  
RSL value for mercuric chloride (and other mercury salts) used for mercury.  
[5] Rationale Codes  
Selection Reason: Above Screening Levels (ASL)  
Deletion Reason: No Toxicity Information (NTX)  
Essential Nutrient (NUT)  
Below Screening Level (BSL)

COPC = Chemical of Potential Concern  
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
To Be Considered  
J = Estimated Value  
K = Biased High  
L = Biased Low  
C = Carcinogenic  
N = Noncarcinogenic  
MG/KG = milligrams per kilogram  
N/A = Not available  
SSL = Risk Based Soil Screening Levels from RSL table (noncarcinogenic endpoints based on hazard quotient of 0.1)  
NL = Noncarcinogenic lead residential soil RSL based on IEUBK model.

Table 2.4  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Emissions from Surface and Subsurface Soil	121-14-2	2,4-Dinitrotoluene	1.0E-07 J	8.8E-06	ug/m <sup>3</sup>	CAA06-SO26-0H02-0913	9/40	N/A	8.8E-06	N/A	3.2E-02 C	N/A	N/A	NO	BSL
	606-20-2	2,6-Dinitrotoluene	2.3E-07 J	2.3E-07 J	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	1/40	N/A	2.3E-07	N/A	N/A	N/A	N/A	NO	NTX
	100-52-7	Benzaldehyde	1.1E-02 J	1.1E-02 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/14	N/A	1.1E-02	N/A	N/A	N/A	N/A	NO	NTX
	56-55-3	Benzo(a)anthracene	8.1E-08 J	8.1E-08 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/14	N/A	8.1E-08	N/A	9.2E-03 C	N/A	N/A	NO	BSL
	218-01-9	Chrysene	1.1E-07 J	1.1E-07 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/14	N/A	1.1E-07	N/A	9.2E-02 C	N/A	N/A	NO	BSL
	206-44-0	Fluoranthene	2.2E-07 J	2.2E-07 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/14	N/A	2.2E-07	N/A	N/A	N/A	N/A	NO	NTX
	129-00-0	Pyrene	1.9E-04 J	1.9E-04 J	ug/m <sup>3</sup>	CAA06-SS01-1008	1/14	N/A	1.9E-04	N/A	N/A	N/A	N/A	NO	NTX
	99-35-4	1,3,5-Trinitrobenzene	1.8E-07	1.5E-05	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	6/40	N/A	1.5E-05	N/A	N/A	N/A	N/A	NO	NTX
	99-65-0	1,3-Dinitrobenzene	2.1E-08 J	1.8E-06	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	8/40	N/A	1.8E-06	N/A	N/A	N/A	N/A	NO	NTX
	118-96-7	2,4,6-Trinitrotoluene	1.3E-07	1.0E-02	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	18/40	N/A	1.0E-02	N/A	N/A	N/A	N/A	NO	NTX
	35572-78-2	2-Amino-4,6-dinitrotoluene	4.5E-07 J	1.2E-05 J	ug/m <sup>3</sup>	CAA06-SS02-1008	13/40	N/A	1.2E-05	N/A	N/A	N/A	N/A	NO	NTX
	88-72-2	2-Nitrotoluene	2.7E-01 J	2.7E-01 J	ug/m <sup>3</sup>	CAA06-SS02-1008	1/39	N/A	2.7E-01	N/A	N/A	N/A	N/A	NO	NTX
	618-87-1	3,5-Dinitroaniline	4.0E-07	1.2E-06	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	3/40	N/A	1.2E-06	N/A	N/A	N/A	N/A	NO	NTX
	19406-51-0	4-Amino-2,6-dinitrotoluene	2.5E-07	2.2E-05	ug/m <sup>3</sup>	CAA06-SB13-1108	13/39	N/A	2.2E-05	N/A	N/A	N/A	N/A	NO	NTX
	99-99-0	4-Nitrotoluene	2.4E-06	2.4E-06	ug/m <sup>3</sup>	CAA06-SB36-0H02-0913	1/39	N/A	2.4E-06	N/A	N/A	N/A	N/A	NO	NTX
	121-82-4	RDX	1.6E-07	2.8E-07 J	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	2/40	N/A	2.8E-07	N/A	N/A	N/A	N/A	NO	NTX
	479-45-8	Tetryl	4.7E-07	4.7E-07	ug/m <sup>3</sup>	CAA06-SS01-1008	1/40	N/A	4.7E-07	N/A	N/A	N/A	N/A	NO	NTX
	7429-90-5	Aluminum	2.0E-03	1.8E-02	ug/m <sup>3</sup>	CAA06-SS03-1008	40/40	N/A	1.8E-02	N/A	5.2E-01 N	N/A	N/A	NO	BSL
	7440-36-0	Antimony	6.5E-08 J	5.3E-07	ug/m <sup>3</sup>	CAA06-SB38-0H02-0913	19/40	N/A	5.3E-07	N/A	N/A	N/A	N/A	NO	NTX
	7440-38-2	Arsenic	8.1E-07	1.5E-05 J	ug/m <sup>3</sup>	CAA06-SB01-1008	40/40	N/A	1.5E-05	N/A	6.5E-04 C	N/A	N/A	NO	BSL
	7440-39-3	Barium	6.9E-06	3.4E-05	ug/m <sup>3</sup>	CAA06-SS03-1008	40/40	N/A	3.4E-05	N/A	5.2E-02 N	N/A	N/A	NO	BSL
	7440-41-7	Beryllium	6.8E-08 J	5.4E-07	ug/m <sup>3</sup>	CAA06-SB01-1008	40/40	N/A	5.4E-07	N/A	1.2E-03 C	N/A	N/A	NO	BSL
	7440-43-9	Cadmium	9.6E-09 J	2.1E-07	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	32/40	N/A	2.1E-07	N/A	1.0E-03 N	N/A	N/A	NO	BSL
	7440-70-2	Calcium	4.5E-05	2.9E-03	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	40/40	N/A	2.9E-03	N/A	N/A	N/A	N/A	NO	NUT
	18540-29-9	Chromium (hexavalent)	2.3E-07 J	6.9E-07	ug/m <sup>3</sup>	CAA06-SB27-0H02-0913	2/4	N/A	6.9E-07	N/A	1.2E-05 C	N/A	N/A	NO	BSL
	7440-47-3	Chromium	2.6E-06	2.7E-05 L	ug/m <sup>3</sup>	CAA06-SB03-1008	44/44	N/A	2.7E-05	N/A	N/A	N/A	N/A	NO	NTX
	7440-48-4	Cobalt	4.2E-07	3.7E-06 J	ug/m <sup>3</sup>	CAA06-SB03-1008	40/40	N/A	3.7E-06	N/A	3.1E-04 C	N/A	N/A	NO	BSL
	7440-50-8	Copper	5.8E-07	9.6E-06 K	ug/m <sup>3</sup>	CAA06-SS36-0913	34/40	N/A	9.6E-06	N/A	N/A	N/A	N/A	NO	NTX
	57-12-5	Cyanide	2.6E-08 J	9.6E-07	ug/m <sup>3</sup>	CAA06-SS13-1108	16/40	N/A	9.6E-07	N/A	8.3E-02 N	N/A	N/A	NO	BSL
	7439-89-6	Iron	2.5E-03	2.8E-02	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	40/40	N/A	2.8E-02	N/A	N/A	N/A	N/A	NO	NTX
	7439-92-1	Lead	2.9E-06	8.1E-04	ug/m <sup>3</sup>	CAA06-SO26-000H-0913	40/40	N/A	8.1E-04	N/A	1.5E-01 N	N/A	N/A	NO	BSL
	7439-95-4	Magnesium	1.5E-04	1.0E-03	ug/m <sup>3</sup>	CAA06-SB03-1008	40/40	N/A	1.0E-03	N/A	N/A	N/A	N/A	NO	NUT
	7439-96-5	Manganese	8.8E-06	1.3E-04	ug/m <sup>3</sup>	CAA06-SS01-1008	40/40	N/A	1.3E-04	N/A	5.2E-03 N	N/A	N/A	NO	BSL
	7439-97-6	Mercury	2.5E-08 J	9.6E-08	ug/m <sup>3</sup>	CAA06-SO26-000H-0913 : CAA06-SS01-1008	26/40	N/A	9.6E-08	N/A	3.1E-02 N	N/A	N/A	NO	BSL

Table 2.4  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection	
Emissions from Surface and Subsurface Soil (cont'd)	7440-02-0	Nickel	1.2E-06	1.3E-05	ug/m <sup>3</sup>	CAA06-SB03-1008	40/40	N/A	1.3E-05	N/A	9.4E-03	N	N/A	N/A	NO	BSL
	7440-09-7	Potassium	1.3E-04	1.2E-03	ug/m <sup>3</sup>	CAA06-SB03-1008	40/40	N/A	1.2E-03	N/A	N/A		N/A	N/A	NO	NUT
	7782-49-2	Selenium	3.6E-08	1.5E-06	J	CAA06-SS01-1008	31/40	N/A	1.5E-06	N/A	2.1E+00	N	N/A	N/A	NO	BSL
	7440-22-4	Silver	8.1E-09	4.0E-08	J	CAA06-SS38-0913	26/40	N/A	4.0E-08	N/A	N/A		N/A	N/A	NO	NTX
	7440-23-5	Sodium	6.4E-06	5.0E-05	J	CAA06-SS01-1008	22/40	N/A	5.0E-05	N/A	N/A		N/A	N/A	NO	NUT
	7440-28-0	Thallium	4.0E-08	1.3E-07	J	CAA06-SS03-1008	28/40	N/A	1.3E-07	N/A	N/A		N/A	N/A	NO	NTX
	7440-62-2	Vanadium	4.7E-06	4.0E-05		CAA06-SB03-1008	40/40	N/A	4.0E-05	N/A	1.0E-02	N	N/A	N/A	NO	BSL
	7440-66-6	Zinc	5.2E-06	1.3E-04		CAA06-SS03-1008	35/40	N/A	1.3E-04	N/A	N/A		N/A	N/A	NO	NTX

[1]

Minimum/Maximum calculated air concentrations from surface and subsurface soil concentrations. Air concentrations calculated as  $C_{air} = C_{soil} * 1000 * (1/PEF + 1/VF)$ .  
PEF = 1.36E+09 m3/kg. VF calculated for volatile constituents only, on Table 2.2A. PEF and VF from USEPA's Soil Screening Guidance. (USEPA, 2002)

[2]

Maximum concentration is used for screening.

[3]

Background values not available.

[4]

Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Residential air RSLs.  
[Online]. Available: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)  
RSL based on noncarcinogenic endpoints based on hazard quotient of 0.1. RSL based on carcinogenic endpoints based on cancer risk of 10-6.

[5]

Rationale Codes

Selection Reason:

Above Screening Levels (ASL)

Deletion Reason:

No Toxicity Information (NTX)

Essential Nutrient (NUT)

Below Screening Level (BSL)

COPC = Chemical of Potential Concern  
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
To Be Considered  
J = Estimated Value  
K = Biased High  
L = Biased Low  
C = Carcinogenic  
N = Noncarcinogenic  
ug/m<sup>3</sup> = micrograms per cubic meter  
N/A = Not available

Table 2.5  
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Tap Water and Water in Excavation Trench	7429-90-5	Aluminum	1.9E+01 J	4.8E+01 J	UG/L	CAA06-GW03-1013	2/4	100 - 100	4.8E+01	ND	2.0E+03 N	50 - 200	SMCL	NO	BSL
	<b>7440-38-2</b>	<b>Arsenic</b>	<b>1.6E+01</b>	<b>3.3E+01</b>	<b>UG/L</b>	<b>CAA06-GW03-1013</b>	<b>4/4</b>	<b>1 - 1</b>	<b>3.3E+01</b>	<b>6.3E+00 - 3.3E+01</b>	<b>5.2E-02 C</b>	<b>1.0E+01</b>	<b>MCL</b>	<b>YES</b>	<b>ASL</b>
	7440-39-3	Barium	8.9E+00	2.5E+01	UG/L	CAA06-GW04-1013	4/4	1 - 1	2.5E+01	1.4E+01 - 1.5E+01	3.8E+02 N	2.0E+03	MCL	NO	BSL
	7440-70-2	Calcium	1.5E+04 J	4.7E+04	UG/L	CAA06-GW04-1013	4/4	500 - 500	4.7E+04	2.2E+04 - 3.8E+04	N/A	N/A	N/A	NO	NUT
	<b>7440-48-4</b>	<b>Cobalt</b>	<b>7.3E-01 J</b>	<b>1.9E+00</b>	<b>UG/L</b>	<b>CAA06-GW02-1013</b>	<b>4/4</b>	<b>1 - 1</b>	<b>1.9E+00</b>	<b>5.6E-01 - 8.7E+00</b>	<b>6.0E-01 N</b>	<b>N/A</b>	<b>N/A</b>	<b>YES</b>	<b>ASL</b>
	<b>57-12-5</b>	<b>Cyanide</b>	<b>1.6E+01</b>	<b>1.6E+01</b>	<b>UG/L</b>	<b>CAA06-GW05-1013</b>	<b>1/4</b>	<b>10 - 10</b>	<b>1.6E+01</b>	<b>ND</b>	<b>1.5E-01 N</b>	<b>2.0E+02</b>	<b>MCL</b>	<b>YES</b>	<b>ASL</b>
	<b>7439-89-6</b>	<b>Iron</b>	<b>1.9E+04</b>	<b>3.6E+04 J</b>	<b>UG/L</b>	<b>CAA06-GW02-1013</b>	<b>4/4</b>	<b>10 - 500</b>	<b>3.6E+04</b>	<b>1.6E+04 - 3.0E+04</b>	<b>1.4E+03 N</b>	<b>3.0E+02</b>	<b>SMCL</b>	<b>YES</b>	<b>ASL</b>
	7439-92-1	Lead	1.9E-01 J	1.9E-01 J	UG/L	CAA06-GW03-1013	1/4	1 - 1	1.9E-01	ND	1.5E+01	1.5E+01	MCL	NO	BSL
	7439-95-4	Magnesium	2.1E+03 J	3.2E+03	UG/L	CAA06-GW04-1013	4/4	500 - 500	3.2E+03	2.8E+03 - 3.6E+03	N/A	N/A	N/A	NO	NUT
	<b>7439-96-5</b>	<b>Manganese</b>	<b>2.1E+02</b>	<b>4.0E+02</b>	<b>UG/L</b>	<b>CAA06-GW04-1013</b>	<b>4/4</b>	<b>5 - 10</b>	<b>4.0E+02</b>	<b>3.4E+02 - 7.1E+02</b>	<b>4.3E+01 N</b>	<b>5.0E+01</b>	<b>SMCL</b>	<b>YES</b>	<b>ASL</b>
	7440-02-0	Nickel	4.6E-01 J	2.3E+00	UG/L	CAA06-GW04-1013	4/4	1 - 1	2.3E+00	7.5E-01 - 1.1E+00	3.9E+01 N	N/A	N/A	NO	BSL
	7440-09-7	Potassium	1.7E+03 J	2.8E+03	UG/L	CAA06-GW04-1013	4/4	100 - 100	2.8E+03	1.6E+03 - 2.6E+03	N/A	N/A	N/A	NO	NUT
	7440-23-5	Sodium	8.0E+03 J	1.2E+04	UG/L	CAA06-GW04-1013	4/4	500 - 500	1.2E+04	7.9E+03 - 9.6E+03	N/A	N/A	N/A	NO	NUT

[1]

Minimum/Maximum detected concentration. Unfiltered results for metals since in general no significant difference between filtered and unfiltered results of aluminum, iron, and manganese in any of the monitoring wells.

[2]

Maximum concentration is used for screening.

[3]

Background/reference values are range of concentrations detected in CAA06-MW01 and CAA06-MW06.

[4]

Oak Ridge National Laboratory (ORNL). May, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites.  
Tap Water RSLs (based on 10<sup>-6</sup> for carcinogens and HQ of 0.1 for noncarcinogens). [Online]. Available: <http://epa-prgs.ornl.gov/chemicals/index.shtml>  
The screening value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.

[5]

Rationale Codes

Selection Reason:

Above Screening Levels (ASL)

Deletion Reason:

No Toxicity Information (NTX)

Essential Nutrient (NUT)

Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
To Be Considered

J = Estimated Value

C = Carcinogenic

N = Noncarcinogenic

UG/L - microgram per liter

N/A = Not available

MCL = Maximum Contaminant Level

SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards

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Table 3.1.RME  
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Surface Soil	2,4-Dinitrotoluene	MG/KG	5.2E-01	1.1E+00 NP	6.3E+00 L	1.1E+00	MG/KG	95% Boot	1, 2, 3
	1,3-Dinitrobenzene	MG/KG	2.5E-01	4.9E-01 NP	2.5E+00	4.9E-01	MG/KG	95% KM-t	1, 2, 3
	2,4,6-Trinitrotoluene	MG/KG	1.0E+03	6.6E+03 G	1.4E+04	6.6E+03	MG/KG	95% GROS Adj.	1, 3
	2-Amino-4,6-dinitrotoluene	MG/KG	2.1E+00	4.1E+00 NP	1.6E+01 J	4.1E+00	MG/KG	95% KM-t	1, 2, 3
	2-Nitrotoluene	MG/KG	N/A	N/A	4.8E+01 J	4.8E+01	MG/KG	Max	5
	4-Amino-2,6-dinitrotoluene	MG/KG	2.8E+00	5.1E+00 NP	1.7E+01	5.1E+00	MG/KG	95% KM-t	1, 2, 3
	Aluminum	MG/KG	7.9E+03	9.7E+03 N	2.5E+04	9.7E+03	MG/KG	95% Stud-t	1, 2, 3
	Arsenic	MG/KG	3.9E+00	4.9E+00 N	1.2E+01 J	4.9E+00	MG/KG	95% Stud-t	1, 2, 3
	Cobalt	MG/KG	2.1E+00	2.4E+00 N	3.6E+00 J	2.4E+00	MG/KG	95% Stud-t	1, 2, 3
	Iron	MG/KG	1.1E+04	1.6E+04 G	3.8E+04	1.6E+04	MG/KG	Adj. Gamma	1, 3
	Lead	MG/KG	1.2E+02	N/A	1.1E+03	1.2E+02	MG/KG	Mean-N	7
	Thallium	MG/KG	9.4E-02	1.1E-01 NP	1.8E-01 J	1.1E-01	MG/KG	95% Boot	1, 3
	Vanadium	MG/KG	1.9E+01	2.3E+01 N	5.0E+01	2.3E+01	MG/KG	95% Stud-t	1, 2, 3

ProUCL, Version 5.0.00 used to determine distribution of data and calculate 95% UCL, following recommendations in users guide (USEPA. September 2013. Prepared by Lockheed Martin Environmental Services).

Options: Maximum Detected Value (Max); 95% Student's-T test UCL (95% Stud-t); 95% Adjusted Gamma UCL (Adj. Gamma); Mean-Normal (Mean-N)  
95% Kaplan-Meier (Percentile Bootstrap) UCL (95% Boot); 95% Kaplan-Meier (t) UCL (95% KM-t); 95% GROS Adjusted Gamma UCL (95% GROS Adj.)

UCL Rationale:

- (1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
- (2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
- (3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
- (4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
- (5) The maximum detected concentration was used because chemical detected in only one sample.
- (6) Maximum detected concentration used because UCL greater than maximum.
- (7) Mean concentration used as EPC for lead model.

G = Gamma  
NP = Non-Parametric  
N = Normal  
N/A = not available/not applicable

MG/KG = milligrams per kilogram  
J = Estimated Value  
L = Biased Low

Table 3.2.RME  
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface and Subsurface Soil	2,4-Dinitrotoluene	MG/KG	5.9E-01	2.0E+00	G	1.2E+01	2.0E+00	MG/KG	Adj. Gamma	1, 3
	1,3-Dinitrobenzene	MG/KG	2.2E-01	3.8E-01	NP	2.5E+00	3.8E-01	MG/KG	95% Boot	1, 2, 3
	2,4,6-Trinitrotoluene	MG/KG	8.4E+02	2.6E+03	G	1.4E+04	2.6E+03	MG/KG	Adj. Gamma	1, 3
	2-Amino-4,6-dinitrotoluene	MG/KG	2.2E+00	3.5E+00	NP	1.6E+01 J	3.5E+00	MG/KG	95% KM-t	1, 2, 3
	2-Nitrotoluene	MG/KG	N/A	N/A		4.8E+01 J	4.8E+01	MG/KG	Max	5
	4-Amino-2,6-dinitrotoluene	MG/KG	2.8E+00	4.6E+00	NP	3.0E+01	4.6E+00	MG/KG	95% Boot	1, 2, 3
	Aluminum	MG/KG	9.2E+03	1.1E+04	N	2.5E+04	1.1E+04	MG/KG	95% Stud-t	1, 2, 3
	Arsenic	MG/KG	4.8E+00	5.9E+00	G	2.1E+01 J	5.9E+00	MG/KG	Adj. Gamma	1, 3
	Chromium (hexavalent)	MG/KG	6.3E-01	N/A		9.4E-01	9.4E-01	MG/KG	Max	6
	Cobalt	MG/KG	2.4E+00	2.6E+00	N	5.0E+00 J	2.6E+00	MG/KG	95% Stud-t	1, 2, 3
	Iron	MG/KG	1.3E+04	1.5E+04	G	3.8E+04	1.5E+04	MG/KG	Adj. Gamma	1, 3
	Lead	MG/KG	8.0E+01	N/A		1.1E+03	8.0E+01	MG/KG	Mean-N	7
	Thallium	MG/KG	1.0E-01	1.1E-01	NP	1.8E-01 J	1.1E-01	MG/KG	95% KM-t	1, 2, 3
	Vanadium	MG/KG	2.1E+01	2.4E+01	N	5.4E+01	2.4E+01	MG/KG	95% Stud-t	1, 2, 3

ProUCL, Version 5.0.00 used to determine distribution of data and calculate 95% UCL, following recommendations in users guide (USEPA. September 2013. Prepared by Lockheed Martin Environmental Services).

Options: 95% Adjusted Gamma UCL (Adj. Gamma); 95% Kaplan-Meier (Percentile Bootstrap) UCL (95% Boot); 95% Kaplan-Meier (t) UCL (95% KM-t); Maximum Detected Value (Max); 95% Student's-T test UCL (95% Stud-t); Mean-Normal (Mean-N)

UCL Rationale:

- (1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
- (2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
- (3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
- (4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
- (5) The maximum detected concentration was used because chemical detected in only one sample.
- (6) The maximum detected concentration was used because the sample set was less than 8 samples.
- (7) Mean concentration used as EPC for lead model.

G = Gamma  
NP = Non-Parametric  
N = Normal

MG/KG = milligrams per kilogram  
J = Estimated Value  
N/A = not available/not applicable

Table 3.3.RME  
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Tap Water and Water in Excavation Trench	Arsenic	UG/L	2.4E+01	3.3E+01	N	3.3E+01	UG/L	95% Stud-t	1, 2, 3
	Cobalt	UG/L	1.1E+00	1.7E+00	N	1.9E+00	UG/L	95% Stud-t	1, 3, 5
	Cyanide	UG/L	N/A	N/A		1.6E+01	UG/L	Max	6
	Iron	UG/L	2.8E+04	3.7E+04	N	3.6E+04	UG/L	Max	1, 2, 3, 5
	Manganese	UG/L	3.0E+02	4.1E+02	N	4.0E+02	UG/L	Max	1, 2, 3, 5

ProUCL, Version 5.0.00 used to determine distribution of data and calculate 95% UCL, following recommendations in users guide (USEPA. September 2013. Prepared by Lockheed Martin Environmental Services).

Options: 95% Student's-T test UCL (95% Stud-t); Maximum Detected Value (Max)

UCL Rationale:

- (1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
- (2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
- (3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
- (4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
- (5) Maximum detected concentration used because UCL greater than maximum.
- (6) The maximum detected concentration was used because chemical detected in only one sample.

G = Gamma

N = Normal

N/A = not available/not applicable

UG/L = micrograms per liter

J - Estimated Value

Table 4.1.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014	
				EF	Exposure Frequency	225	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Recreational User	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	20	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	
		Child	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	200	mg/day	EPA, 2014	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	

Table 4.1.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current

Medium: Surface Soil

Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Base Worker	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.12	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	225	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Recreational User	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.07	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	
		Child	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	

Notes:

(1) Professional Judgment assuming 2 day per week for 26 weeks per year.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.  
EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.  
EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.  
EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014.

TABLE 4.2.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014	
				EF	Exposure Frequency	225	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Recreational User	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	20	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	
		Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	200	mg/day	EPA, 2014	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
	Construction Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 2002	
				EF	Exposure Frequency	125	days/year	VDEQ, 2003	
				ED	Exposure Duration	1	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	

TABLE 4.2.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion (cont'd)	Resident	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	
		Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	200	mg/day	EPA, 2014	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S-Adj x EF x CF1 x 1/AT  IR-S-Adj (mg-year/kd-day) = (ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				IR-S-A	Ingestion Rate of Soil, Adult	100	mg/day	EPA, 2014	
				IR-S-C	Ingestion Rate of Soil, Child	200	mg/day	EPA, 2014	
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	105	mg-year/kg-day	Calculated	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED-A	Exposure Duration, Adult	20	years	EPA, 2014	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal	Base Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.12	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	225	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

TABLE 4.2.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Recreational User	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.07	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	
		Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm <sup>2</sup>	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	chemical specific	--	EPA, 2004	
				CF3	Conversion Factor 3	0.000001	kg/mg	--	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
	Construction Worker	Adult	Surface and Subsurface Soil	AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm <sup>2</sup> -day	EPA, 2011	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	125	days/year	VDEQ, 2003	
				ED	Exposure Duration	1	years	EPA, 1991	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Resident	Adult	Surface and Subsurface Soil	AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	
				CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.07	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 1989	

TABLE 4.2.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Resident	Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm <sup>2</sup> -day	EPA, 2014	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x DA-Adj x DABS x CF1 x EF x 1/AT  DA-Adj (mg-year/kg-day) =  (ED-C x SA-C x SSAF-C / BW-C) + (ED-A x SA-A x SSAF-A / BW-A)
				SA-A	Skin Surface Area Available for Contact, Adult	6,032	cm <sup>2</sup>	EPA, 2014	
				SA-C	Skin Surface Area Available for Contact, Child	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF-A	Soil to Skin Adherence Factor, Adult	0.07	mg/cm <sup>2</sup> -day	EPA, 2014	
				SSAF-C	Soil to Skin Adherence Factor, Child	0.2	mg/cm <sup>2</sup> -day	EPA, 2014	
				DA-Adj	Dermal Absorption, Age-adjusted	321	mg-year/kg-day	Calculated	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED-A	Exposure Duration, Adult	20	years	EPA, 2014	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Notes:

(1) Professional judgment assuming 2 day per week for 26 weeks per year.

Sources:

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TABLE 4.3.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	$CDI\ (mg/kg\text{-}day) = CW \times IR\text{-}W \times EF \times ED \times CF \times 1/BW \times 1/AT$
				IR-W	Ingestion Rate of Water	1.25	liters/day	EPA, 2014 (1)	
				EF	Exposure Frequency	250	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Resident	Adult	Tap Water	AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	$Chronic\ Daily\ Intake\ (CDI)\ (mg/kg\text{-}day) = CW \times IR\text{-}W \times EF \times ED \times CF1 \times 1/BW \times 1/AT$
				IR-W	Ingestion Rate of Water	2.5	liters/day	EPA, 2014	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	80	kg	EPA, 2014	
		Child	Tap Water	AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 2014	
				CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	$CDI\ (mg/kg\text{-}day) = CW \times IR\text{-}W \times EF \times ED \times CF1 \times 1/BW \times 1/AT$
				IR-W	Ingestion Rate of Water	0.78	liters/day	EPA, 2014	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
		Child/Adult	Tap Water	BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	$CDI\ (mg/kg\text{-}day) = CW \times IR\text{-}W\text{-}Adj \times EF \times CF1 \times 1/AT$  $IR\text{-}W\text{-}Adj\ (liter\text{-}year/kd\text{-}day) = (ED\text{-}C \times IR\text{-}W\text{-}C / BW\text{-}C) + (ED\text{-}A \times IR\text{-}W\text{-}A / BW\text{-}A)$
				IR-W-A	Ingestion Rate of Water, Adult	2.5	liters/day	EPA, 2014	
				IR-W-C	Ingestion Rate of Water, Child	0.78	liters/day	EPA, 2014	
				IR-W-Adj	Ingestion Rate of Water, Age-adjusted	0.94	liter-year/kg-day	calculated	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED-A	Exposure Duration, Adult	20	years	EPA, 2014	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

TABLE 4.3.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DAevent x SA x EV x EF x ED x 1/BW x 1/AT  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004	
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical-specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	0.71	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	20,900	cm <sup>2</sup>	EPA, 2014	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -	
	Child	Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DAevent x SA x EV x EF x ED x 1/BW x 1/AT  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004	
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical-specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	0.54	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	6,378	cm <sup>2</sup>	EPA, 2014	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -	

TABLE 4.3.RME  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name				
Dermal (cont'd)	Resident	Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DA-Adj x EF x 1/AT  DA-Adj = (DAevent-A x SA-A x ED-A x 1/BW-A) + (DAevent-C x SA-C x ED-C x 1/BW-C)  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1 x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2				
				DAevent-A	Dermally Absorbed Dose per Event, Adult	Calculated	mg/cm <sup>2</sup> -event	calculated					
				DAevent-C	Dermally Absorbed Dose per Event, Child	Calculated	mg/cm <sup>2</sup> -event	calculated					
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg-year/event-kg	calculated					
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004					
				K <sub>p</sub>	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004					
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004					
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004					
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical-specific	dimensionless	EPA, 2004					
				t <sub>event</sub> -A	Event Time, Adult	0.71	hr/event	EPA, 2014					
				t <sub>event</sub> -C	Event Time, Child	0.54	hr/event	EPA, 2014					
				SA-A	Skin Surface Area, Adult	20,900	cm <sup>2</sup>	EPA, 2014					
				SA-C	Skin Surface Area, Child	6,378	cm <sup>2</sup>	EPA, 2014					
				EV	Event Frequency	1	events/day	EPA, 2004					
				EF	Exposure Frequency	350	days/year	EPA, 2014					
				ED-A	Exposure Duration, Adult	20	years	EPA, 2014					
				ED-C	Exposure Duration, Child	6	years	EPA, 2014					
				BW-A	Body Weight, Adult	80	kg	EPA, 2014					
				BW-C	Body Weight, Child	15	kg	EPA, 2014					
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989					
				CF1	Conversion Factor 1	0.001	mg/µg	- -					
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -					
				Construction Worker	Adult	Water in Excavation Trench	CW	Chemical Concentration in Water		See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DAevent x SA x EV x EF x ED x 1/BW x 1/AT  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF2 x CF3  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF2 x CF3  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF2 x CF3
							DAevent	Dermally Absorbed Dose per Event		calculated	mg/cm <sup>2</sup> -event	calculated	
							FA	Fraction absorbed water		chemical specific	dimensionless	EPA, 2004	
							K <sub>p</sub>	Permeability Coefficient		chemical specific	cm/hr	EPA, 2004	
	t	Lag Time	chemical specific				hr/event	EPA, 2004					
	t*	Time to Reach Steady-state	chemical specific				hours	EPA, 2004					
	B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific				dimensionless	EPA, 2004					
	t <sub>event</sub>	Event Time	8				hr/day	(2)					
	SA	Skin Surface Area Available for Contact	6,032				cm <sup>2</sup>	EPA, 2014 (3)					
	EV	Event Frequency	1				events/day	EPA, 2004					
	EF	Exposure Frequency	125				days/year	VDEQ, 2003					
	ED	Exposure Duration	1				years	EPA, 1991					
	BW	Body Weight	80				kg	EPA, 2014					
	AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989								
	AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989								
	CF2	Conversion Factor 2	0.001	mg/µg	- -								
	CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	- -								

(1) As recommended by EPA, 1991, one half the adult resident ingestion rate of water (from EPA, 2014) used for the industrial worker.  
(2) Professional judgment based on construction activities that would occur 8 hrs per day for the RME.  
(3) Surface area for adult resident exposed to soil from EPA, 2014, and includes weighted average of mean values for head, hands, forearms, lower legs, and feet.

Sources:  
EPA, 1989: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.  
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EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.  
EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014.  
VDEQ, 2003: Virginia Department of Environmental Quality, Voluntary Remediation Program Risk Assessment Guidance. Dec. 2003.

Table 4.1.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	50	mg/day	EPA, 1993	
				EF	Exposure Frequency	219	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Recreational User	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	20	mg/day	EPA, 2011 (1)	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
		Child	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	47	mg/day	EPA, 2011 (4)	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 2014	
Dermal	Base Worker	Adult	Surface Soil	AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.02	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	219	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2004	
				BW	Body Weight	80	kg	EPA, 2014	

Table 4.1.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Medium: Surface Soil  
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Recreational User	Adult	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.01	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
		Child	Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1	mg/kg	See Table 3.1	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.04	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	

Notes:

- (1) Table 5-1, general population central tendency value for adult.  
(2) Professional judgment assuming 1/2 RME exposure.  
(3) Table 16-108. Descriptive Statistics for Residential Occupancy Period. 50th percentile value for both sexes.  
(4) Table 5-1, calculated using the general population central tendency values for birth to <6 years, based on time-weighted average, as follows: ((11 months x 30 mg/day)+(60 months x 50 mg/day))/71 months

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.  
EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.  
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EPA, 2011. Exposure Factors Handbook: 2011 Edition. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. Available from the National Technical Information Service, Springfield, VA, and online at <http://www.epa.gov/ncea/efh>.  
EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014.

TABLE 4.2.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	50	mg/day	EPA, 1993	
				EF	Exposure Frequency	219	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Recreational User	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	20	mg/day	EPA, 2011 (1)	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
		Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	47	mg/day	EPA, 2011 (4)	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
	Construction Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2014 (5)	
				EF	Exposure Frequency	125	days/year	VDEQ, 2003	
				ED	Exposure Duration	1	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	

TABLE 4.2.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion (cont'd)	Resident	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	20	mg/day	EPA, 2011 (1)	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
		Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	47	mg/day	EPA, 2011 (4)	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S-Adj x EF x CF1 x 1/AT  IR-S-Adj (mg-year/kd-day) = (ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				IR-S-A	Ingestion Rate of Soil, Adult	20	mg/day	EPA, 2011 (1)	
				IR-S-C	Ingestion Rate of Soil, Child	47	mg/day	EPA, 2011 (4)	
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	21	mg-year/kg-day	Calculated	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED-A	Exposure Duration, Adult	9	years	EPA, 2011 (3)	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

TABLE 4.2.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Base Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.02	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	219	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2004	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Recreational User	Adult	Surface and Subsurface Soil	AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.01	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				BW	Body Weight	80	kg	EPA, 2014	
		Child	Surface and Subsurface Soil	AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
				CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.04	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF3	Conversion Factor 3	0.000001	kg/mg	--	
				EF	Exposure Frequency	26	days/year	(2)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	

TABLE 4.2.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Construction Worker	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,470	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.1	mg/cm <sup>2</sup> -day	EPA, 2004, (6)	
				DABS	Dermal Absorption Factor Solids	chem specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	125	days/year	VDEQ, 2003	
				ED	Exposure Duration	1	years	EPA, 1991	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	
	Resident	Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,032	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.01	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2011 (3)	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Resident	Child	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF	Soil to Skin Adherence Factor	0.04	mg/cm <sup>2</sup> -day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	--	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	

TABLE 4.2.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Surface and Subsurface Soil  
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)		Child/Adult	Surface and Subsurface Soil	CS	Chemical Concentration in Soil	See Table 3.2	mg/kg	See Table 3.2	CDI (mg/kg-day) = CS x DA-Adj x DABS x CF1 x EF x 1/AT  DA-Adj (mg-year/kg-day) =  (ED-C x SA-C x SSAF-C / BW-C) + (ED-A x SA-A x SSAF-A / BW-A)
				SA-A	Skin Surface Area Available for Contact, Adult	6,032	cm <sup>2</sup>	EPA, 2014	
				SA-C	Skin Surface Area Available for Contact, Child	2,690	cm <sup>2</sup>	EPA, 2014	
				SSAF-A	Soil to Skin Adherence Factor, Adult	0.01	mg/cm <sup>2</sup> -day	EPA, 2004	
				SSAF-C	Soil to Skin Adherence Factor, Child	0.04	mg/cm <sup>2</sup> -day	EPA, 2004	
				DA-Adj	Dermal Absorption, Age-adjusted	50	mg-year/kg-day	Calculated	
				DABS	Dermal Absorption Factor Solids	Chemical specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED-A	Exposure Duration, Adult	9	years	EPA, 2011 (3)	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

- Notes:
- (1) Table 5-1, general population central tendency value for adult.
  - (2) Professional judgment assuming 1/2 RME exposure.
  - (3) Table 16-108, 50th percentile value for both sexes.
  - (4) Table 5-1, calculated using the general population central tendency values for birth to <6 years, based on time-weighted average, as follows: ((11 months x 30 mg/day)+(60 months x 50 mg/day))/71 months:
  - (5) Outdoor worker soil ingestion rate.
  - (6) Soil to skin adherence factor is based on geometric mean adherence factor for construction workers.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

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EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.

EPA, 2011. Exposure Factors Handbook: 2011 Edition. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. Available from the National Technical Information Service, Springfield, VA, and online at <http://www.epa.gov/ncea/efh>.

EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014.

VDEQ, 2003: Virginia Department of Environmental Quality, Voluntary Remediation Program Risk Assessment Guidance. Dec. 2003.

TABLE 4.3.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Base Worker	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = CW x IR-W x EF x ED x CF x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	0.5	liters/day	EPA, 2011 (1)	
				EF	Exposure Frequency	219	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2004	
				CF	Conversion Factor 1	0.001	mg/µg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	Chronic Daily Intake (CDI) (mg/kg-day) = CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	0.99	liters/day	EPA, 2011	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2011 (2)	
				CF1	Conversion Factor 1	0.001	mg/µg	--	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 2014	
		Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	0.31	liters/day	EPA, 2011	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	--	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = CW x IR-W-Adj x EF x CF1 x 1/AT  IR-W-Adj (liter-year/kd-day) = (ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A)
				IR-W-A	Ingestion Rate of Water, Adult	0.99	liters/day	EPA, 2011	
				IR-W-C	Ingestion Rate of Water, Child	0.31	liters/day	EPA, 2011	
				IR-W-Adj	Ingestion Rate of Water, Age-adjusted	0.24	liter-year/kg-day	calculated	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED-A	Exposure Duration, Adult	9	years	EPA, 2011 (2)	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	--	
				BW-A	Body Weight , Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

TABLE 4.3.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DAevent x SA x EV x EF x ED x 1/BW x 1/AT  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004	
				K <sub>p</sub>	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004	
					Ratio of Permeability of Stratum Corneum to Epidermis				
				B	Epidermis	Chemical-specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	0.28	hr/event	EPA, 2011 (3)	
				SA	Skin Surface Area Available for Contact	20,900	cm <sup>2</sup>	EPA, 2014	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	9	years	EPA, 2011 (2)	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 2014	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -	
		Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DAevent x SA x EV x EF x ED x 1/BW x 1/AT  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004	
				K <sub>p</sub>	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004	
					Ratio of Permeability of Stratum Corneum to Epidermis				
				B	Epidermis	Chemical-specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	0.37	hr/event	EPA, 2011 (4)	
				SA	Skin Surface Area Available for Contact	6,378	cm <sup>2</sup>	EPA, 2014	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -	

TABLE 4.3.CTE  
VALUES USED FOR DAILY INTAKE CALCULATIONS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Resident	Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.3	µg/l	See Table 3.3	CDI (mg/kg-day) = DA-Adj x EF x 1/AT  DA-Adj = (DAevent-A x SA-A x ED-A x 1/BW-A) + (DAevent-C x SA-C x ED-C x 1/BW-C)  Inorganics: DAevent (mg/cm <sup>2</sup> -event) = Kp x CW x t <sub>event</sub> x CF1 x CF2  Organics : t <sub>event</sub> <t*: DAevent (mg/cm <sup>2</sup> -event) = 2 x FA x Kp x CW x (sqrt((6 x t x t <sub>event</sub> )/p)) x CF1 x CF2  t <sub>event</sub> >t*: DAevent (mg/cm <sup>2</sup> -event) = FA x Kp x CW x ( t <sub>event</sub> /(1+B) + 2 x t x ((1 + 3B + 3B <sup>2</sup> )/(1+B) <sup>2</sup> )) x CF1 x CF2
				DAevent-A	Dermally Absorbed Dose per Event, Adult	Calculated	mg/cm <sup>2</sup> -event	calculated	
				DAevent-C	Dermally Absorbed Dose per Event, Child	Calculated	mg/cm <sup>2</sup> -event	calculated	
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg-year/event-kg	calculated	
				FA	Fraction absorbed water	Chemical-specific	dimensionless	EPA, 2004	
				K <sub>p</sub>	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				t	Lag Time	Chemical-specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical-specific	hours	EPA, 2004	
					Ratio of Permeability of Stratum Corneum to Epidermis				
				B	Epidermis	Chemical-specific	dimensionless	EPA, 2004	
				t <sub>event</sub> -A	Event Time, Adult	0.28	hr/event	EPA, 2011 (3)	
				t <sub>event</sub> -C	Event Time, Child	0.37	hr/event	EPA, 2011 (4)	
				SA-A	Skin Surface Area, Adult	20,900	cm <sup>2</sup>	EPA, 2014	
				SA-C	Skin Surface Area, Child	6,378	cm <sup>2</sup>	EPA, 2014	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED-A	Exposure Duration, Adult	9	years	EPA, 2011 (2)	
				ED-C	Exposure Duration, Child	6	years	EPA, 2014	
				BW-A	Body Weight, Adult	80	kg	EPA, 2014	
				BW-C	Body Weight, Child	15	kg	EPA, 2014	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	- -	

- (1) As recommended by EPA, 1991, one half the adult resident ingestion rate of water (one half the CTE value used).  
(2) Table 16-108, 50th percentile value for both sexes.  
(3) Table 16-1, mean value for time spent bathing/showering (ages 18 years and older). 17 minutes/day divided by 60 minutes/hour.  
(4) Table 16-1, mean value for time spent bathing (birth to <6 years). 22 minutes/day divided by 60 minutes/hour.

Sources:  
EPA, 1989: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.  
EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July 2004.  
EPA, 2011. Exposure Factors Handbook: 2011 Edition. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. Available from the National Technical Information Service, Springfield, VA, and online at <http://www.epa.gov/ncea/efh>.  
EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6, 2014.  
VDEQ, 2003: Virginia Department of Environmental Quality, Voluntary Remediation Program Risk Assessment Guidance. Dec. 2003.

TABLE 5.1  
NON-CANCER TOXICITY DATA -- ORAL/DERMAL  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (MM/DD/YY)
2-Amino-4,6-dinitrotoluene (3)	Chronic Subchronic	2.0E-03 N/A	mg/kg-day	>50%	2.0E-03 N/A	mg/kg-day	Neurological, Blood, Biliary Tract	100	IRIS	04/24/14
4-Amino-2,6-dinitrotoluene (3)	Chronic Subchronic	2.0E-03 N/A	mg/kg-day	>50%	2.0E-03 N/A	mg/kg-day	Neurological, Blood, Biliary Tract	100	IRIS	04/24/14
2,4-Dinitrotoluene	Chronic Subchronic	2.0E-03 7.0E-03	mg/kg-day mg/kg-day	>50% >50%	2.0E-03 7.0E-03	mg/kg-day mg/kg-day	Neurological, Blood, Biliary Tract Blood	100 100	IRIS ATSDR	4/24/2014 4/2013
1,3-Dinitrobenzene	Chronic Subchronic	1.0E-04 5.0E-04	mg/kg-day mg/kg-day	>50% >50%	1.0E-04 5.0E-04	mg/kg-day mg/kg-day	Spleen Blood	3000 1000	IRIS ATSDR	4/24/2014 6/1995
2-Nitrotoluene	Chronic Subchronic	9.0E-04 1.0E-02	mg/kg-day mg/kg-day	>50% >50%	9.0E-04 1.0E-02	mg/kg-day mg/kg-day	Bone Marrow Spleen, Blood	1000 3000	PPRTV PPRTV	8/15/2008 8/15/2008
2,4,6-Trinitrotoluene	Chronic Subchronic	5.0E-04 5.0E-04	mg/kg-day mg/kg-day	>50% >50%	5.0E-04 5.0E-04	mg/kg-day mg/kg-day	Liver Liver	1000 1000	IRIS ATSDR	4/24/2014 6/1995
Aluminum	Chronic Subchronic	1.0E+00 1.0E+00	mg/kg-day mg/kg-day	N/A N/A	1.0E+00 1.0E+00	mg/kg-day mg/kg-day	Neurological Neurological	100 30	PPRTV ATSDR	10/23/2006 9/2008
Arsenic	Chronic Subchronic	3.0E-04 3.0E-04	mg/kg-day mg/kg-day	95% 95%	3.0E-04 3.0E-04	mg/kg-day mg/kg-day	Skin, Vascular Skin	3/1 3	IRIS HEAST	4/24/2014 7/1997
Chromium (hexavalent)	Chronic Subchronic	3.0E-03 5.0E-03	mg/kg-day mg/kg-day	2.5% 2.5%	7.5E-05 1.3E-04	mg/kg-day mg/kg-day	NOE Blood	300/1 100	IRIS ATSDR	4/24/2014 9/2012
Cobalt	Chronic Subchronic	3.0E-04 3.0E-03	mg/kg-day mg/kg-day	N/A N/A	3.0E-04 3.0E-03	mg/kg/day mg/kg/day	Thyroid Thyroid	3000 300	PPRTV PPRTV	8/25/2008 8/25/2008
Cyanide	Chronic Subchronic	6.0E-04 2.0E-02	mg/kg-day mg/kg/day	N/A N/A	6.0E-04 2.0E-02	mg/kg/day mg/kg/day	Reproductive Whole Body, Thyroid, Neurological	3000 300	IRIS HEAST	4/24/2014 7/1997
Iron	Chronic Subchronic	7.0E-01 7.0E-01	mg/kg/day mg/kg/day	N/A N/A	7.0E-01 7.0E-01	mg/kg/day mg/kg/day	Gastrointestinal Gastrointestinal	1.5 1.5	PPRTV PPRTV	9/11/2006 9/11/2006
Lead	Chronic Subchronic	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
Manganese (non-diet)	Chronic Subchronic	2.4E-02 N/A	mg/kg-day N/A	4% N/A	9.6E-04 N/A	mg/kg-day N/A	Neurological N/A	1/1 N/A	IRIS N/A	4/24/2014 N/A
Thallium	Chronic Subchronic	1.0E-05 4.0E-05	mg/kg-day mg/kg-day	100% 100%	1.0E-05 4.0E-05	mg/kg-day mg/kg-day	Hair Hair	3000 1000	PPRTV PPRTV	10/25/2012 10/25/2012
Vanadium	Chronic Subchronic	5.0E-03 1.0E-02	mg/kg-day mg/kg-day	2.6% 2.6%	1.3E-04 2.6E-04	mg/kg-day mg/kg-day	Kidney Blood	300 10	RSL/IRIS ATSDR	04/24/14 9/2012

Notes:

- (1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1. USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.
- (2) Adjusted based on RAGS Part E. (dermal RfD = Oral RfD x oral absorption efficiency)
- (3) As included on the RSL table, the RfD for 2,4-diotrotoluene used for 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene

Definitions: ATSDR = Agency for Toxic Substances and Disease Registry  
CNS = Central Nervous System  
HEAST = Health Effects Assessment Summary Tables  
IRIS = Integrated Risk Information System  
N/A = Not Available  
NOE = No Observed Effects  
PPRTV = Provisional Peer-Reviewed Toxicity Value

TABLE 6.1  
CANCER TOXICITY DATA -- ORAL/DERMAL  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal Cancer Slope Factor (2)	Units	Carcinogenicity Classification	Source	Date (MM/DD/YY)
2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,4-Dinitrotoluene	3.1E-01	> 50%	3.1E-01	(mg/kg-day) <sup>-1</sup>	2B	Cal EPA	4/24/2014
1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	D	IRIS	4/24/2014
2-Nitrotoluene	2.2E-01	> 50%	2.2E-01	(mg/kg-day) <sup>-1</sup>	LI	PPRTV	8/15/2008
2,4,6-Trinitrotoluene	3.0E-02	> 50%	3.0E-02	(mg/kg-day) <sup>-1</sup>	C	IRIS	4/24/2014
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	1.5E+00	95%	1.5E+00	(mg/kg-day) <sup>-1</sup>	A	IRIS	4/24/2014
Chromium (hexavalent) (3)	5.0E-01	2.5%	2.0E+01	(mg/kg-day) <sup>-1</sup>	D	NJ DEP/IRIS	4/8/2009, 4/24/2014
Cobalt	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cyanide	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1. USEPA recommends that the oral slope factor should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Adjusted based on RAGS Part E. (dermal CSF = Oral CSF / oral absorption efficiency)

(3) This chemical operates with a mutagenic mode of action. Chemical-specific data are not available; therefore, default age-dependant adjustment factors (ADAF) will be applied to the slope factor as follows:

AGE	AGE ADAF
0-<2	10
2-<6	3
6-<16	3
16-<30	1

Definitions: CalEPA = California Environmental Protection Agency  
IRIS = Integrated Risk Information System  
LI = Likely to be carcinogenic to humans  
N/A = Not Available  
NJ DEP = New Jersey Department of Environmental Protection

Weight of Evidence definitions:  
Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer  
Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and inadequate or a lack of human data  
Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available  
2B: The agent is possibly carcinogenic to humans

TABLE 7.1.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations							
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient			
							Value	Units	Value	Units		Value	Units	Value	Units				
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	3.1E-07	mg/kg-day	3.1E-01	mg/kg-day	9.7E-08	8.8E-07	mg/kg-day	2.0E-03	mg/kg-day	4.4E-04			
				1,3-Dinitrobenzene	4.9E-01	mg/kg	1.3E-07	mg/kg-day	N/A		N/A	3.8E-07	mg/kg-day	1.0E-04	mg/kg-day	3.8E-03			
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.8E-03	mg/kg-day	3.0E-02	mg/kg-day	5.4E-05	5.1E-03	mg/kg-day	5.0E-04	mg/kg-day	1.0E+01			
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	1.1E-06	mg/kg-day	N/A		N/A	3.2E-06	mg/kg-day	2.0E-03	mg/kg-day	1.6E-03			
				2-Nitrotoluene	4.8E+01	mg/kg	1.3E-05	mg/kg-day	2.2E-01	mg/kg-day	2.9E-06	3.7E-05	mg/kg-day	9.0E-04	mg/kg-day	4.1E-02			
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	1.4E-06	mg/kg-day	N/A		N/A	3.9E-06	mg/kg-day	2.0E-03	mg/kg-day	1.9E-03			
				Aluminum	9.7E+03	mg/kg	2.7E-03	mg/kg-day	N/A		N/A	7.5E-03	mg/kg-day	1.0E+00	mg/kg-day	7.5E-03			
				Arsenic	4.9E+00	mg/kg	1.4E-06	mg/kg-day	1.5E+00	mg/kg-day	2.0E-06	3.8E-06	mg/kg-day	3.0E-04	mg/kg-day	1.3E-02			
				Cobalt	2.4E+00	mg/kg	6.5E-07	mg/kg-day	N/A		N/A	1.8E-06	mg/kg-day	3.0E-04	mg/kg-day	6.1E-03			
				Iron	1.6E+04	mg/kg	4.3E-03	mg/kg-day	N/A		N/A	1.2E-02	mg/kg-day	7.0E-01	mg/kg-day	1.7E-02			
				Thallium	1.1E-01	mg/kg	3.0E-08	mg/kg-day	N/A		N/A	8.3E-08	mg/kg-day	1.0E-05	mg/kg-day	8.3E-03			
				Vanadium	2.3E+01	mg/kg	6.2E-06	mg/kg-day	N/A		N/A	1.7E-05	mg/kg-day	5.0E-03	mg/kg-day	3.5E-03			
				Exp. Route Total	Vanadium									5.9E-05					1.0E+01
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	1.3E-07	mg/kg-day	3.1E-01	mg/kg-day	4.1E-08	3.7E-07	mg/kg-day	2.0E-03	mg/kg-day	1.9E-04			
				1,3-Dinitrobenzene	4.9E-01	mg/kg	5.6E-08	mg/kg-day	N/A		N/A	1.6E-07	mg/kg-day	1.0E-04	mg/kg-day	1.6E-03			
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	2.4E-04	mg/kg-day	3.0E-02	mg/kg-day	7.2E-06	6.7E-04	mg/kg-day	5.0E-04	mg/kg-day	1.3E+00			
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	2.8E-08	mg/kg-day	N/A		N/A	8.0E-08	mg/kg-day	2.0E-03	mg/kg-day	4.0E-05			
				2-Nitrotoluene	4.8E+01	mg/kg	5.5E-06	mg/kg-day	2.2E-01	mg/kg-day	1.2E-06	1.5E-05	mg/kg-day	9.0E-04	mg/kg-day	1.7E-02			
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	5.2E-08	mg/kg-day	N/A		N/A	1.5E-07	mg/kg-day	2.0E-03	mg/kg-day	7.3E-05			
				Aluminum	9.7E+03	mg/kg	1.1E-04	mg/kg-day	N/A		N/A	3.1E-04	mg/kg-day	1.0E+00	mg/kg-day	3.1E-04			
				Arsenic	4.9E+00	mg/kg	1.7E-07	mg/kg-day	1.5E+00	mg/kg-day	2.5E-07	4.7E-07	mg/kg-day	3.0E-04	mg/kg-day	1.6E-03			
				Cobalt	2.4E+00	mg/kg	2.7E-08	mg/kg-day	N/A		N/A	7.6E-08	mg/kg-day	3.0E-04	mg/kg-day	2.5E-04			
				Iron	1.6E+04	mg/kg	1.8E-04	mg/kg-day	N/A		N/A	5.1E-04	mg/kg-day	7.0E-01	mg/kg-day	7.2E-04			
				Thallium	1.1E-01	mg/kg	1.2E-09	mg/kg-day	N/A		N/A	3.5E-09	mg/kg-day	1.0E-05	mg/kg-day	3.5E-04			
				Vanadium	2.3E+01	mg/kg	2.6E-07	mg/kg-day	N/A		N/A	7.3E-07	mg/kg-day	1.3E-04	mg/kg-day	5.6E-03			
				Exp. Route Total										8.7E-06					1.4E+00
			Exposure Point Total												6.8E-05				
		Exposure Medium Total												6.8E-05					1.2E+01
		Surface Soil Total												6.8E-05					1.2E+01
		Total of Receptor Risks Across All Media											6.8E-05	Total of Receptor Hazards Across All Media					1.2E+01

Notes:  
N/A =Not available; Not applicable.  
<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.  
DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,  
DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.2.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	5.8E-08	mg/kg-day	3.1E-01	mg/kg-day	1.8E-08	2.0E-07	mg/kg-day	2.0E-03	mg/kg-day	1.0E-04	
				1,3-Dinitrobenzene	4.9E-01	mg/kg	2.5E-08	mg/kg-day	N/A		N/A	8.7E-08	mg/kg-day	1.0E-04	mg/kg-day	8.7E-04	
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	3.3E-04	mg/kg-day	3.0E-02	mg/kg-day	1.0E-05	1.2E-03	mg/kg-day	5.0E-04	mg/kg-day	2.3E+00	
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	2.1E-07	mg/kg-day	N/A		N/A	7.4E-07	mg/kg-day	2.0E-03	mg/kg-day	3.7E-04	
				2-Nitrotoluene	4.8E+01	mg/kg	2.4E-06	mg/kg-day	2.2E-01	mg/kg-day	5.4E-07	8.5E-06	mg/kg-day	9.0E-04	mg/kg-day	9.5E-03	
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	2.6E-07	mg/kg-day	N/A		N/A	9.0E-07	mg/kg-day	2.0E-03	mg/kg-day	4.5E-04	
				Aluminum	9.7E+03	mg/kg	5.0E-04	mg/kg-day	N/A		N/A	1.7E-03	mg/kg-day	1.0E+00	mg/kg-day	1.7E-03	
				Arsenic	4.9E+00	mg/kg	2.5E-07	mg/kg-day	1.5E+00	mg/kg-day	3.7E-07	8.7E-07	mg/kg-day	3.0E-04	mg/kg-day	2.9E-03	
				Cobalt	2.4E+00	mg/kg	1.2E-07	mg/kg-day	N/A		N/A	4.2E-07	mg/kg-day	3.0E-04	mg/kg-day	1.4E-03	
				Iron	1.6E+04	mg/kg	8.0E-04	mg/kg-day	N/A		N/A	2.8E-03	mg/kg-day	7.0E-01	mg/kg-day	4.0E-03	
				Thallium	1.1E-01	mg/kg	5.5E-09	mg/kg-day	N/A		N/A	1.9E-08	mg/kg-day	1.0E-05	mg/kg-day	1.9E-03	
				Vanadium	2.3E+01	mg/kg	1.2E-06	mg/kg-day	N/A		N/A	4.0E-06	mg/kg-day	5.0E-03	mg/kg-day	8.1E-04	
			Exp. Route Total							1.1E-05					2.4E+00		
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	2.5E-08	mg/kg-day	3.1E-01	mg/kg-day	7.7E-09	8.7E-08	mg/kg-day	2.0E-03	mg/kg-day	4.4E-05	
				1,3-Dinitrobenzene	4.9E-01	mg/kg	1.0E-08	mg/kg-day	N/A		N/A	3.7E-08	mg/kg-day	1.0E-04	mg/kg-day	3.7E-04	
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	4.5E-05	mg/kg-day	3.0E-02	mg/kg-day	1.4E-06	1.6E-04	mg/kg-day	5.0E-04	mg/kg-day	3.2E-01	
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	5.3E-09	mg/kg-day	N/A		N/A	1.9E-08	mg/kg-day	2.0E-03	mg/kg-day	9.3E-06	
				2-Nitrotoluene	4.8E+01	mg/kg	1.0E-06	mg/kg-day	2.2E-01	mg/kg-day	2.3E-07	3.6E-06	mg/kg-day	9.0E-04	mg/kg-day	4.0E-03	
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	9.8E-09	mg/kg-day	N/A		N/A	3.4E-08	mg/kg-day	2.0E-03	mg/kg-day	1.7E-05	
				Aluminum	9.7E+03	mg/kg	2.1E-05	mg/kg-day	N/A		N/A	7.3E-05	mg/kg-day	1.0E+00	mg/kg-day	7.3E-05	
				Arsenic	4.9E+00	mg/kg	3.2E-08	mg/kg-day	1.5E+00	mg/kg-day	4.7E-08	1.1E-07	mg/kg-day	3.0E-04	mg/kg-day	3.7E-04	
				Cobalt	2.4E+00	mg/kg	5.1E-09	mg/kg-day	N/A		N/A	1.8E-08	mg/kg-day	3.0E-04	mg/kg-day	5.9E-05	
				Iron	1.6E+04	mg/kg	3.4E-05	mg/kg-day	N/A		N/A	1.2E-04	mg/kg-day	7.0E-01	mg/kg-day	1.7E-04	
				Thallium	1.1E-01	mg/kg	2.3E-10	mg/kg-day	N/A		N/A	8.1E-10	mg/kg-day	1.0E-05	mg/kg-day	8.1E-05	
				Vanadium	2.3E+01	mg/kg	4.9E-08	mg/kg-day	N/A		N/A	1.7E-07	mg/kg-day	1.3E-04	mg/kg-day	1.3E-03	
			Exp. Route Total							1.6E-06					3.2E-01		
			Exposure Point Total								1.3E-05					2.7E+00	
		Exposure Medium Total								1.3E-05					2.7E+00		
		Surface Soil Total										1.3E-05					2.7E+00
								Total of Receptor Risks Across All Media				1.3E-05	Total of Receptor Hazards Across All Media				2.7E+00

Notes:  
N/A =Not available; Not applicable.  
<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil and sediment are chemical specific.  
DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,  
DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.3.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
				Value			Units	Value	Units	Value		Units	Value	Units		
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	1.8E-07	mg/kg-day	3.1E-01	mg/kg-day	5.7E-08	2.2E-06	mg/kg-day	2.0E-03	mg/kg-day	1.1E-03
				1,3-Dinitrobenzene	4.9E-01	mg/kg	7.9E-08	mg/kg-day	N/A		N/A	9.3E-07	mg/kg-day	1.0E-04	mg/kg-day	9.3E-03
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.1E-03	mg/kg-day	3.0E-02	mg/kg-day	3.2E-05	1.2E-02	mg/kg-day	5.0E-04	mg/kg-day	2.5E+01
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	6.7E-07	mg/kg-day	N/A		N/A	7.9E-06	mg/kg-day	2.0E-03	mg/kg-day	3.9E-03
				2-Nitrotoluene	4.8E+01	mg/kg	7.8E-06	mg/kg-day	2.2E-01	mg/kg-day	1.7E-06	9.1E-05	mg/kg-day	9.0E-04	mg/kg-day	1.0E-01
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	8.2E-07	mg/kg-day	N/A		N/A	9.6E-06	mg/kg-day	2.0E-03	mg/kg-day	4.8E-03
				Aluminum	9.7E+03	mg/kg	1.6E-03	mg/kg-day	N/A		N/A	1.9E-02	mg/kg-day	1.0E+00	mg/kg-day	1.9E-02
				Arsenic	4.9E+00	mg/kg	8.0E-07	mg/kg-day	1.5E+00	mg/kg-day	1.2E-06	9.3E-06	mg/kg-day	3.0E-04	mg/kg-day	3.1E-02
				Cobalt	2.4E+00	mg/kg	3.8E-07	mg/kg-day	N/A		N/A	4.5E-06	mg/kg-day	3.0E-04	mg/kg-day	1.5E-02
				Iron	1.6E+04	mg/kg	2.6E-03	mg/kg-day	N/A		N/A	3.0E-02	mg/kg-day	7.0E-01	mg/kg-day	4.3E-02
				Thallium	1.1E-01	mg/kg	1.8E-08	mg/kg-day	N/A		N/A	2.1E-07	mg/kg-day	1.0E-05	mg/kg-day	2.1E-02
				Vanadium	2.3E+01	mg/kg	3.7E-06	mg/kg-day	N/A		N/A	4.3E-05	mg/kg-day	5.0E-03	mg/kg-day	8.6E-03
			Exp. Route Total							3.5E-05				2.5E+01		
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	5.1E-08	mg/kg-day	3.1E-01	mg/kg-day	1.6E-08	5.9E-07	mg/kg-day	2.0E-03	mg/kg-day	3.0E-04
				1,3-Dinitrobenzene	4.9E-01	mg/kg	2.1E-08	mg/kg-day	N/A		N/A	2.5E-07	mg/kg-day	1.0E-04	mg/kg-day	2.5E-03
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	9.2E-05	mg/kg-day	3.0E-02	mg/kg-day	2.8E-06	1.1E-03	mg/kg-day	5.0E-04	mg/kg-day	2.1E+00
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	1.1E-08	mg/kg-day	N/A		N/A	1.3E-07	mg/kg-day	2.0E-03	mg/kg-day	6.3E-05
				2-Nitrotoluene	4.8E+01	mg/kg	2.1E-06	mg/kg-day	2.2E-01	mg/kg-day	4.6E-07	2.5E-05	mg/kg-day	9.0E-04	mg/kg-day	2.7E-02
		4-Amino-2,6-dinitrotoluene		5.1E+00	mg/kg	2.0E-08	mg/kg-day	N/A		N/A	2.3E-07	mg/kg-day	2.0E-03	mg/kg-day	1.2E-04	
		Aluminum		9.7E+03	mg/kg	4.3E-05	mg/kg-day	N/A		N/A	5.0E-04	mg/kg-day	1.0E+00	mg/kg-day	5.0E-04	
		Arsenic		4.9E+00	mg/kg	6.4E-08	mg/kg-day	1.5E+00	mg/kg-day	9.7E-08	7.5E-07	mg/kg-day	3.0E-04	mg/kg-day	2.5E-03	
		Cobalt		2.4E+00	mg/kg	1.0E-08	mg/kg-day	N/A		N/A	1.2E-07	mg/kg-day	3.0E-04	mg/kg-day	4.0E-04	
		Iron		1.6E+04	mg/kg	6.9E-05	mg/kg-day	N/A		N/A	8.1E-04	mg/kg-day	7.0E-01	mg/kg-day	1.2E-03	
		Thallium		1.1E-01	mg/kg	4.7E-10	mg/kg-day	N/A		N/A	5.5E-09	mg/kg-day	1.0E-05	mg/kg-day	5.5E-04	
		Vanadium		2.3E+01	mg/kg	9.9E-08	mg/kg-day	N/A		N/A	1.2E-06	mg/kg-day	1.3E-04	mg/kg-day	8.9E-03	
		Exp. Route Total							3.3E-06				2.2E+00			
		Exposure Point Total							3.8E-05				2.7E+01			
			Exposure Medium Total						3.8E-05				2.7E+01			
Surface Soil Total										3.8E-05				2.7E+01		
Total of Receptor Risks Across All Media										3.8E-05	Total of Receptor Hazards Across All Media				2.7E+01	

Notes:

N/A =Not available; Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil and sediment are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives, DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.4.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	5.4E-07	mg/kg-day	3.1E-01	mg/kg-day	1.7E-07	1.5E-06	mg/kg-day	2.0E-03	mg/kg-day	7.6E-04	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.0E-07	mg/kg-day	N/A	N/A	2.9E-07	mg/kg-day	1.0E-04	mg/kg-day	2.9E-03		
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	7.1E-04	mg/kg-day	3.0E-02	mg/kg-day	2.1E-05	2.0E-03	mg/kg-day	5.0E-04	mg/kg-day	4.0E+00	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	9.6E-07	mg/kg-day	N/A	N/A	2.7E-06	mg/kg-day	2.0E-03	mg/kg-day	1.3E-03		
				2-Nitrotoluene	4.8E+01	mg/kg	1.3E-05	mg/kg-day	2.2E-01	mg/kg-day	2.9E-06	3.7E-05	mg/kg-day	9.0E-04	mg/kg-day	4.1E-02	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	1.3E-06	mg/kg-day	N/A	N/A	3.5E-06	mg/kg-day	2.0E-03	mg/kg-day	1.8E-03		
				Aluminum	1.1E+04	mg/kg	2.9E-03	mg/kg-day	N/A	N/A	8.1E-03	mg/kg-day	1.0E+00	mg/kg-day	8.1E-03		
				Arsenic	5.9E+00	mg/kg	1.6E-06	mg/kg-day	1.5E+00	mg/kg-day	2.4E-06	4.5E-06	mg/kg-day	3.0E-04	mg/kg-day	1.5E-02	
				Chromium (hexavalent)	9.4E-01	mg/kg	2.6E-07	mg/kg-day	5.0E-01	mg/kg-day	1.3E-07	7.2E-07	mg/kg-day	3.0E-03	mg/kg-day	2.4E-04	
				Cobalt	2.6E+00	mg/kg	7.3E-07	mg/kg-day	N/A	N/A	2.0E-06	mg/kg-day	3.0E-04	mg/kg-day	6.8E-03		
				Iron	1.5E+04	mg/kg	4.2E-03	mg/kg-day	N/A	N/A	1.2E-02	mg/kg-day	7.0E-01	mg/kg-day	1.7E-02		
				Thallium	1.1E-01	mg/kg	3.1E-08	mg/kg-day	N/A	N/A	8.8E-08	mg/kg-day	1.0E-05	mg/kg-day	8.8E-03		
				Vanadium	2.4E+01	mg/kg	6.6E-06	mg/kg-day	N/A	N/A	1.8E-05	mg/kg-day	5.0E-03	mg/kg-day	3.7E-03		
			Exp. Route Total	2.4E+01								2.7E-05					4.1E+00
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	2.3E-07	mg/kg-day	3.1E-01	mg/kg-day	7.1E-08	6.4E-07	mg/kg-day	2.0E-03	mg/kg-day	3.2E-04	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	4.3E-08	mg/kg-day	N/A	N/A	N/A	1.2E-07	mg/kg-day	1.0E-04	mg/kg-day	1.2E-03	
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	9.4E-05	mg/kg-day	3.0E-02	mg/kg-day	2.8E-06	2.6E-04	mg/kg-day	5.0E-04	mg/kg-day	5.3E-01	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	2.4E-08	mg/kg-day	N/A	N/A	N/A	6.7E-08	mg/kg-day	2.0E-03	mg/kg-day	3.3E-05	
				2-Nitrotoluene	4.8E+01	mg/kg	5.5E-06	mg/kg-day	2.2E-01	mg/kg-day	1.2E-06	1.5E-05	mg/kg-day	9.0E-04	mg/kg-day	1.7E-02	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	4.7E-08	mg/kg-day	N/A	N/A	N/A	1.3E-07	mg/kg-day	2.0E-03	mg/kg-day	6.6E-05	
				Aluminum	1.1E+04	mg/kg	1.2E-04	mg/kg-day	N/A	N/A	N/A	3.4E-04	mg/kg-day	1.0E+00	mg/kg-day	3.4E-04	
				Arsenic	5.9E+00	mg/kg	2.0E-07	mg/kg-day	1.5E+00	mg/kg-day	3.0E-07	5.7E-07	mg/kg-day	3.0E-04	mg/kg-day	1.9E-03	
				Chromium (hexavalent)	9.4E-01	mg/kg	1.1E-08	mg/kg-day	2.0E+01	mg/kg-day	2.2E-07	3.0E-08	mg/kg-day	7.5E-05	mg/kg-day	4.0E-04	
				Cobalt	2.6E+00	mg/kg	3.0E-08	mg/kg-day	N/A	N/A	N/A	8.5E-08	mg/kg-day	3.0E-04	mg/kg-day	2.8E-04	
				Iron	1.5E+04	mg/kg	1.8E-04	mg/kg-day	N/A	N/A	N/A	4.9E-04	mg/kg-day	7.0E-01	mg/kg-day	7.1E-04	
				Thallium	1.1E-01	mg/kg	1.3E-09	mg/kg-day	N/A	N/A	N/A	3.7E-09	mg/kg-day	1.0E-05	mg/kg-day	3.7E-04	
				Vanadium	2.4E+01	mg/kg	2.7E-07	mg/kg-day	N/A	N/A	N/A	7.6E-07	mg/kg-day	1.3E-04	mg/kg-day	5.9E-03	
			Exp. Route Total									4.6E-06					5.6E-01
		Exposure Point Total										3.1E-05					4.6E+00
	Exposure Medium Total										3.1E-05					4.6E+00	
Surface and Subsurface Soil Total											3.1E-05					4.6E+00	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	1.2E-04	mg/kg-day	1.5E+00	1/mg/kg-day	1.9E-04	3.5E-04	mg/kg-day	3.0E-04	mg/kg-day	1.2E+00	
				Cobalt	1.7E+00	ug/L	6.7E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	1.9E-05	mg/kg-day	3.0E-04	mg/kg-day	6.2E-02	
				Cyanide	1.6E+01	ug/L	6.0E-05	mg/kg-day	N/A	1/mg/kg-day	N/A	1.7E-04	mg/kg-day	6.0E-04	mg/kg-day	2.8E-01	
				Iron	3.6E+04	ug/L	1.4E-01	mg/kg-day	N/A	1/mg/kg-day	N/A	3.9E-01	mg/kg-day	7.0E-01	mg/kg-day	5.5E-01	
				Manganese	4.0E+02	ug/L	1.5E-03	mg/kg-day	N/A	1/mg/kg-day	N/A	4.3E-03	mg/kg-day	2.4E-02	mg/kg-day	1.8E-01	
	Exp. Route Total										1.9E-04					2.2E+00	
Exposure Medium Total										1.9E-04					2.2E+00		
Groundwater Total											1.9E-04					2.2E+00	
							Total of Receptor Risk				2.2E-04	Total of Receptor Hazard				6.9E+00	

TABLE 7.4.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	

Notes-

N/A = Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.  
DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,  
DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.5.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	1.0E-07	mg/kg-day	3.1E-01	mg/kg-day	3.1E-08	3.5E-07	mg/kg-day	2.0E-03	mg/kg-day	1.7E-04
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.9E-08	mg/kg-day	N/A		N/A	6.7E-08	mg/kg-day	1.0E-04	mg/kg-day	6.7E-04
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	1.3E-04	mg/kg-day	3.0E-02	mg/kg-day	3.9E-06	4.6E-04	mg/kg-day	5.0E-04	mg/kg-day	9.1E-01
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	1.8E-07	mg/kg-day	N/A		N/A	6.2E-07	mg/kg-day	2.0E-03	mg/kg-day	3.1E-04
				2-Nitrotoluene	4.8E+01	mg/kg	2.4E-06	mg/kg-day	2.2E-01	mg/kg-day	5.4E-07	8.5E-06	mg/kg-day	9.0E-04	mg/kg-day	9.5E-03
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	2.3E-07	mg/kg-day	N/A		N/A	8.1E-07	mg/kg-day	2.0E-03	mg/kg-day	4.1E-04
				Aluminum	1.1E+04	mg/kg	5.3E-04	mg/kg-day	N/A		N/A	1.9E-03	mg/kg-day	1.0E+00	mg/kg-day	1.9E-03
				Arsenic	5.9E+00	mg/kg	3.0E-07	mg/kg-day	1.5E+00	mg/kg-day	4.5E-07	1.0E-06	mg/kg-day	3.0E-04	mg/kg-day	3.5E-03
				Chromium (hexavalent)	9.4E-01	mg/kg	4.8E-08	mg/kg-day	5.0E-01	mg/kg-day	2.4E-08	1.7E-07	mg/kg-day	3.0E-03	mg/kg-day	5.6E-05
				Cobalt	2.6E+00	mg/kg	1.3E-07	mg/kg-day	N/A		N/A	4.7E-07	mg/kg-day	3.0E-04	mg/kg-day	1.6E-03
				Iron	1.5E+04	mg/kg	7.8E-04	mg/kg-day	N/A		N/A	2.7E-03	mg/kg-day	7.0E-01	mg/kg-day	3.9E-03
				Thallium	1.1E-01	mg/kg	5.8E-09	mg/kg-day	N/A		N/A	2.0E-08	mg/kg-day	1.0E-05	mg/kg-day	2.0E-03
				Vanadium	2.4E+01	mg/kg	1.2E-06	mg/kg-day	N/A		N/A	4.2E-06	mg/kg-day	5.0E-03	mg/kg-day	8.5E-04
				Exp. Route Total							5.0E-06					9.4E-01
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	4.3E-08	mg/kg-day	3.1E-01	mg/kg-day	1.3E-08	1.5E-07	mg/kg-day	2.0E-03	mg/kg-day	7.5E-05
				1,3-Dinitrobenzene	3.8E-01	mg/kg	8.1E-09	mg/kg-day	N/A		N/A	2.8E-08	mg/kg-day	1.0E-04	mg/kg-day	2.8E-04
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	1.8E-05	mg/kg-day	3.0E-02	mg/kg-day	5.3E-07	6.2E-05	mg/kg-day	5.0E-04	mg/kg-day	1.2E-01
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	4.5E-09	mg/kg-day	N/A		N/A	1.6E-08	mg/kg-day	2.0E-03	mg/kg-day	7.8E-06
				2-Nitrotoluene	4.8E+01	mg/kg	1.0E-06	mg/kg-day	2.2E-01	mg/kg-day	2.3E-07	3.6E-06	mg/kg-day	9.0E-04	mg/kg-day	4.0E-03
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	8.8E-09	mg/kg-day	N/A		N/A	3.1E-08	mg/kg-day	2.0E-03	mg/kg-day	1.5E-05
				Aluminum	1.1E+04	mg/kg	2.3E-05	mg/kg-day	N/A		N/A	7.9E-05	mg/kg-day	1.0E+00	mg/kg-day	7.9E-05
				Arsenic	5.9E+00	mg/kg	3.8E-08	mg/kg-day	1.5E+00	mg/kg-day	5.7E-08	1.3E-07	mg/kg-day	3.0E-04	mg/kg-day	4.4E-04
				Chromium (hexavalent)	9.4E-01	mg/kg	2.0E-09	mg/kg-day	2.0E+01	mg/kg-day	4.0E-08	7.1E-09	mg/kg-day	7.5E-05	mg/kg-day	9.4E-05
				Cobalt	2.6E+00	mg/kg	5.7E-09	mg/kg-day	N/A		N/A	2.0E-08	mg/kg-day	3.0E-04	mg/kg-day	6.6E-05
				Iron	1.5E+04	mg/kg	3.3E-05	mg/kg-day	N/A		N/A	1.2E-04	mg/kg-day	7.0E-01	mg/kg-day	1.7E-04
				Thallium	1.1E-01	mg/kg	2.4E-10	mg/kg-day	N/A		N/A	8.6E-10	mg/kg-day	1.0E-05	mg/kg-day	8.6E-05
				Vanadium	2.4E+01	mg/kg	5.1E-08	mg/kg-day	N/A		N/A	1.8E-07	mg/kg-day	1.3E-04	mg/kg-day	1.4E-03
				Exp. Route Total							8.7E-07					1.3E-01
		Exposure Point Total								5.8E-06					1.1E+00	
		Exposure Medium Total								5.8E-06					1.1E+00	
Surface and Subsurface Soil Total											5.8E-06					1.1E+00
							Total of Receptor Risk				5.8E-06	Total of Receptor Hazard				1.1E+00

Notes-

N/A = Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.6.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	3.2E-07	mg/kg-day	3.1E-01	mg/kg-day	9.9E-08	3.7E-06	mg/kg-day	2.0E-03	mg/kg-day	1.9E-03
				1,3-Dinitrobenzene	3.8E-01	mg/kg	6.1E-08	mg/kg-day	N/A		N/A	7.1E-07	mg/kg-day	1.0E-04	mg/kg-day	7.1E-03
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	4.2E-04	mg/kg-day	3.0E-02	mg/kg-day	1.3E-05	4.9E-03	mg/kg-day	5.0E-04	mg/kg-day	9.8E+00
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	5.7E-07	mg/kg-day	N/A		N/A	6.6E-06	mg/kg-day	2.0E-03	mg/kg-day	3.3E-03
				2-Nitrotoluene	4.8E+01	mg/kg	7.8E-06	mg/kg-day	2.2E-01	mg/kg-day	1.7E-06	9.1E-05	mg/kg-day	9.0E-04	mg/kg-day	1.0E-01
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	7.4E-07	mg/kg-day	N/A		N/A	8.7E-06	mg/kg-day	2.0E-03	mg/kg-day	4.3E-03
				Aluminum	1.1E+04	mg/kg	1.7E-03	mg/kg-day	N/A		N/A	2.0E-02	mg/kg-day	1.0E+00	mg/kg-day	2.0E-02
				Arsenic	5.9E+00	mg/kg	9.6E-07	mg/kg-day	1.5E+00	mg/kg-day	1.4E-06	1.1E-05	mg/kg-day	3.0E-04	mg/kg-day	3.7E-02
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg			5.0E-01	mg/kg-day	4.1E-07	1.8E-06	mg/kg-day	3.0E-03	mg/kg-day	6.0E-04
				Cobalt	2.6E+00	mg/kg	4.3E-07	mg/kg-day	N/A		N/A	5.0E-06	mg/kg-day	3.0E-04	mg/kg-day	1.7E-02
				Iron	1.5E+04	mg/kg	2.5E-03	mg/kg-day	N/A		N/A	2.9E-02	mg/kg-day	7.0E-01	mg/kg-day	4.2E-02
				Thallium	1.1E-01	mg/kg	1.9E-08	mg/kg-day	N/A		N/A	2.2E-07	mg/kg-day	1.0E-05	mg/kg-day	2.2E-02
				Vanadium	2.4E+01	mg/kg	3.9E-06	mg/kg-day	N/A		N/A	4.5E-05	mg/kg-day	5.0E-03	mg/kg-day	9.0E-03
			Exp. Route Total							1.6E-05					1.0E+01	
			Dermal Absorption <sup>2</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	8.8E-08	mg/kg-day	3.1E-01	mg/kg-day	2.7E-08	1.0E-06	mg/kg-day	2.0E-03	mg/kg-day	5.1E-04
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.6E-08	mg/kg-day	N/A		N/A	1.9E-07	mg/kg-day	1.0E-04	mg/kg-day	1.9E-03
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	3.6E-05	mg/kg-day	3.0E-02	mg/kg-day	1.1E-06	4.2E-04	mg/kg-day	5.0E-04	mg/kg-day	8.4E-01
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	9.1E-09	mg/kg-day	N/A		N/A	1.1E-07	mg/kg-day	2.0E-03	mg/kg-day	5.3E-05
				2-Nitrotoluene	4.8E+01	mg/kg	2.1E-06	mg/kg-day	2.2E-01	mg/kg-day	4.6E-07	2.5E-05	mg/kg-day	9.0E-04	mg/kg-day	2.7E-02
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	1.8E-08	mg/kg-day	N/A		N/A	2.1E-07	mg/kg-day	2.0E-03	mg/kg-day	1.1E-04
		Aluminum		1.1E+04	mg/kg	4.6E-05	mg/kg-day	N/A		N/A	5.4E-04	mg/kg-day	1.0E+00	mg/kg-day	5.4E-04	
		Arsenic		5.9E+00	mg/kg	7.7E-08	mg/kg-day	1.5E+00	mg/kg-day	1.2E-07	9.0E-07	mg/kg-day	3.0E-04	mg/kg-day	3.0E-03	
		Chromium (hexavalent) <sup>1</sup>		9.4E-01	mg/kg			2.0E+01	mg/kg-day	4.4E-07	4.8E-08	mg/kg-day	7.5E-05	mg/kg-day	6.4E-04	
		Cobalt		2.6E+00	mg/kg	1.2E-08	mg/kg-day	N/A		N/A	1.3E-07	mg/kg-day	3.0E-04	mg/kg-day	4.5E-04	
		Iron		1.5E+04	mg/kg	6.7E-05	mg/kg-day	N/A		N/A	7.9E-04	mg/kg-day	7.0E-01	mg/kg-day	1.1E-03	
		Thallium		1.1E-01	mg/kg	5.0E-10	mg/kg-day	N/A		N/A	5.8E-09	mg/kg-day	1.0E-05	mg/kg-day	5.8E-04	
		Vanadium		2.4E+01	mg/kg	1.0E-07	mg/kg-day	N/A		N/A	1.2E-06	mg/kg-day	1.3E-04	mg/kg-day	9.4E-03	
		Exp. Route Total							2.1E-06					8.9E-01		
		Exposure Point Total								1.8E-05					1.1E+01	
		Exposure Medium Total								1.8E-05					1.1E+01	
Surface and Subsurface Soil Total										1.8E-05					1.1E+01	
Total of Receptor Risk											1.8E-05	Total of Receptor Hazard				1.1E+01

Notes-

N/A = Not applicable.

<sup>1</sup> See Table 7.6.RME Supplement A for calculation of intake and cancer risk following MMOA method.

<sup>2</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives, DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.6.RME Supplement A  
 CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
 REASONABLE MAXIMUM EXPOSURE  
 AOC 6 TNT Subareas - Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						
					Value	Units	Intake		CSF/Unit Risk			Cancer Risk	
							Value		Units	Value			Units
							0-2 yrs	2-6 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	Chromium (hexavalent)	9.4E-01	mg/kg	5.1E-08	1.0E-07	mg/kg-day	5.0E+00	1.5E+00	1/(mg/kg-day)	4.1E-07
			Dermal	Chromium (hexavalent)	9.4E-01	mg/kg	1.4E-09	2.7E-09	mg/kg-day	2.0E+02	6.0E+01	1/(mg/kg-day)	4.4E-07

$$\text{Cancer risk} = (\text{Intake}_{0-2} \times \text{CSF}_{0-2}) + (\text{Intake}_{2-6} \times \text{CSF}_{2-6})$$

Notes:

ADAF = Age-dependent adjustment factor

CSF = Cancer slope factor

EPC = Exposure point concentration

mg/kg = milligram per kilogram

mg/kg/day = milligram per kilogram per day

TABLE 7.7.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	4.0E-08	mg/kg-day	3.1E-01	mg/kg-day	1.2E-08	2.8E-06	mg/kg-day	7.0E-03	mg/kg-day	4.0E-04		
				1,3-Dinitrobenzene	3.8E-01	mg/kg	7.6E-09	mg/kg-day	N/A	N/A	5.3E-07	mg/kg-day	5.0E-04	mg/kg-day	1.1E-03			
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	5.2E-05	mg/kg-day	3.0E-02	mg/kg-day	1.6E-06	3.6E-03	mg/kg-day	5.0E-04	mg/kg-day	7.3E+00		
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	7.0E-08	mg/kg-day	N/A	N/A	4.9E-06	mg/kg-day	2.0E-03	mg/kg-day	2.5E-03			
				2-Nitrotoluene	4.8E+01	mg/kg	9.7E-07	mg/kg-day	2.2E-01	mg/kg-day	2.1E-07	6.8E-05	mg/kg-day	1.0E-02	mg/kg-day	6.8E-03		
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	9.2E-08	mg/kg-day	N/A	N/A	6.5E-06	mg/kg-day	2.0E-03	mg/kg-day	3.2E-03			
				Aluminum	1.1E+04	mg/kg	2.1E-04	mg/kg-day	N/A	N/A	1.5E-02	mg/kg-day	1.0E+00	mg/kg-day	1.5E-02			
				Arsenic	5.9E+00	mg/kg	1.2E-07	mg/kg-day	1.5E+00	mg/kg-day	1.8E-07	8.3E-06	mg/kg-day	3.0E-04	mg/kg-day	2.8E-02		
				Chromium (hexavalent)	9.4E-01	mg/kg	1.9E-08	mg/kg-day	5.0E-01	mg/kg-day	9.5E-09	1.3E-06	mg/kg-day	5.0E-03	mg/kg-day	2.7E-04		
				Cobalt	2.6E+00	mg/kg	5.3E-08	mg/kg-day	N/A	N/A	3.7E-06	mg/kg-day	3.0E-03	mg/kg-day	1.2E-03			
				Iron	1.5E+04	mg/kg	3.1E-04	mg/kg-day	N/A	N/A	2.2E-02	mg/kg-day	7.0E-01	mg/kg-day	3.1E-02			
				Thallium	1.1E-01	mg/kg	2.3E-09	mg/kg-day	N/A	N/A	1.6E-07	mg/kg-day	4.0E-05	mg/kg-day	4.0E-03			
				Vanadium	2.4E+01	mg/kg	4.8E-07	mg/kg-day	N/A	N/A	3.4E-05	mg/kg-day	1.0E-02	mg/kg-day	3.4E-03			
			Exp. Route Total									2.0E-06					7.4E+00	
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	1.3E-08	mg/kg-day	3.1E-01	mg/kg-day	3.9E-09	8.9E-07	mg/kg-day	7.0E-03	mg/kg-day	1.3E-04		
				1,3-Dinitrobenzene	3.8E-01	mg/kg	2.4E-09	mg/kg-day	N/A	N/A	N/A	1.7E-07	mg/kg-day	5.0E-04	mg/kg-day	3.3E-04		
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	5.2E-06	mg/kg-day	3.0E-02	mg/kg-day	1.6E-07	3.7E-04	mg/kg-day	5.0E-04	mg/kg-day	7.3E-01		
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	1.3E-09	mg/kg-day	N/A	N/A	N/A	9.3E-08	mg/kg-day	2.0E-03	mg/kg-day	4.6E-05		
				2-Nitrotoluene	4.8E+01	mg/kg	3.1E-07	mg/kg-day	2.2E-01	mg/kg-day	6.7E-08	2.1E-05	mg/kg-day	1.0E-02	mg/kg-day	2.1E-03		
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	2.6E-09	mg/kg-day	N/A	N/A	N/A	1.8E-07	mg/kg-day	2.0E-03	mg/kg-day	9.2E-05		
				Aluminum	1.1E+04	mg/kg	6.7E-06	mg/kg-day	N/A	N/A	N/A	4.7E-04	mg/kg-day	1.0E+00	mg/kg-day	4.7E-04		
				Arsenic	5.9E+00	mg/kg	1.1E-08	mg/kg-day	1.5E+00	mg/kg-day	1.7E-08	7.9E-07	mg/kg-day	3.0E-04	mg/kg-day	2.6E-03		
				Chromium (hexavalent)	9.4E-01	mg/kg	6.0E-10	mg/kg-day	2.0E+01	mg/kg-day	1.2E-08	4.2E-08	mg/kg-day	1.3E-04	mg/kg-day	3.4E-04		
				Cobalt	2.6E+00	mg/kg	1.7E-09	mg/kg-day	N/A	N/A	N/A	1.2E-07	mg/kg-day	3.0E-03	mg/kg-day	3.9E-05		
				Iron	1.5E+04	mg/kg	9.8E-06	mg/kg-day	N/A	N/A	N/A	6.9E-04	mg/kg-day	7.0E-01	mg/kg-day	9.8E-04		
				Thallium	1.1E-01	mg/kg	7.3E-11	mg/kg-day	N/A	N/A	N/A	5.1E-09	mg/kg-day	4.0E-05	mg/kg-day	1.3E-04		
				Vanadium	2.4E+01	mg/kg	1.5E-08	mg/kg-day	N/A	N/A	N/A	1.1E-06	mg/kg-day	2.6E-04	mg/kg-day	4.1E-03		
			Exp. Route Total									2.6E-07					7.4E-01	
			Exposure Point Total										2.2E-06					8.1E+00
			Exposure Medium Total										2.2E-06					8.1E+00
Surface and Subsurface Soil Total											2.2E-06					8.1E+00		
Groundwater	Groundwater	Water in Excavation Trench	Dermal	Arsenic	3.3E+01	ug/L	9.6E-08	mg/kg-day	1.5E+00	1/mg/kg-day	1.4E-07	6.7E-06	mg/kg-day	3.0E-04	mg/kg-day	2.2E-02		
				Cobalt	1.7E+00	ug/L	2.1E-09	mg/kg-day	N/A	1/mg/kg-day	N/A	1.4E-07	mg/kg-day	3.0E-03	mg/kg-day	4.8E-05		
				Cyanide	1.6E+01	ug/L	4.6E-08	mg/kg-day	N/A	1/mg/kg-day	N/A	3.2E-06	mg/kg-day	2.0E-02	mg/kg-day	1.6E-04		
				Iron	3.6E+04	ug/L	1.1E-04	mg/kg-day	N/A	1/mg/kg-day	N/A	7.4E-03	mg/kg-day	7.0E-01	mg/kg-day	1.1E-02		
				Manganese	4.0E+02	ug/L	1.2E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	8.3E-05	mg/kg-day	9.6E-04	mg/kg-day	8.6E-02		
Exp. Route Total										1.4E-07					1.2E-01			
Exposure Medium Total										1.4E-07					1.2E-01			
Groundwater Total											1.4E-07					1.2E-01		
Total of Receptor Risk											2.4E-06	Total of Receptor Hazard				8.2E+00		

Notes-

N/A = Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

DAevent for exposure to groundwater calculated on Table 7.7.RME Supplement A.

Table 7.7.RME Supplement A  
Calculation of DAevent for Groundwater  
Adult Construction Worker  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Water Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (t <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	3.3E+01	1.0E-03	N/A	N/A	N/A	N/A	8	2.6E-07	1
Cobalt	1.7E+00	4.0E-04	N/A	N/A	N/A	N/A	8	5.6E-09	1
Cyanide	1.6E+01	1.0E-03	N/A	N/A	N/A	N/A	8	1.2E-07	1
Iron	3.6E+04	1.0E-03	N/A	N/A	N/A	N/A	8	2.9E-04	1
Manganese	4.0E+02	1.0E-03	N/A	N/A	N/A	N/A	8	3.2E-06	1

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm<sup>3</sup> (eq 1)

TABLE 7.8.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	2.4E-06	mg/kg-day	2.0E-03	mg/kg-day	1.2E-03	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	4.5E-07	mg/kg-day	1.0E-04	mg/kg-day	4.5E-03	
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	3.1E-03	mg/kg-day	5.0E-04	mg/kg-day	6.2E+00	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	4.2E-06	mg/kg-day	2.0E-03	mg/kg-day	2.1E-03	
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	5.8E-05	mg/kg-day	9.0E-04	mg/kg-day	6.4E-02	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	5.5E-06	mg/kg-day	2.0E-03	mg/kg-day	2.7E-03	
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	1.3E-02	mg/kg-day	1.0E+00	mg/kg-day	1.3E-02	
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	7.1E-06	mg/kg-day	3.0E-04	mg/kg-day	2.4E-02	
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	1.1E-06	mg/kg-day	3.0E-03	mg/kg-day	3.8E-04	
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	3.2E-06	mg/kg-day	3.0E-04	mg/kg-day	1.1E-02	
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	1.8E-02	mg/kg-day	7.0E-01	mg/kg-day	2.6E-02	
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	1.4E-07	mg/kg-day	1.0E-05	mg/kg-day	1.4E-02	
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	2.9E-05	mg/kg-day	5.0E-03	mg/kg-day	5.7E-03	
			Exp. Route Total									N/A					6.3E+00
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	1.0E-06	mg/kg-day	2.0E-03	mg/kg-day	5.1E-04	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	1.9E-07	mg/kg-day	1.0E-04	mg/kg-day	1.9E-03	
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	4.2E-04	mg/kg-day	5.0E-04	mg/kg-day	8.3E-01	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	1.1E-07	mg/kg-day	2.0E-03	mg/kg-day	5.3E-05	
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	2.4E-05	mg/kg-day	9.0E-04	mg/kg-day	2.7E-02	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	2.1E-07	mg/kg-day	2.0E-03	mg/kg-day	1.0E-04	
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	5.3E-04	mg/kg-day	1.0E+00	mg/kg-day	5.3E-04	
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	9.0E-07	mg/kg-day	3.0E-04	mg/kg-day	3.0E-03	
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	4.8E-08	mg/kg-day	7.5E-05	mg/kg-day	6.3E-04	
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	1.3E-07	mg/kg-day	3.0E-04	mg/kg-day	4.4E-04	
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	7.8E-04	mg/kg-day	7.0E-01	mg/kg-day	1.1E-03	
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	5.8E-09	mg/kg-day	1.0E-05	mg/kg-day	5.8E-04	
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	1.2E-06	mg/kg-day	1.3E-04	mg/kg-day	9.3E-03	
			Exp. Route Total									N/A					8.8E-01
		Exposure Point Total									N/A					7.2E+00	
	Exposure Medium Total									N/A					7.2E+00		
Surface and Subsurface Soil Total										N/A					7.2E+00		
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	9.8E-04	mg/kg-day	3.0E-04	mg/kg-day	3.3E+00	
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	5.2E-05	mg/kg-day	3.0E-04	mg/kg-day	1.7E-01	
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	4.7E-04	mg/kg-day	6.0E-04	mg/kg-day	7.8E-01	
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	1.1E+00	mg/kg-day	7.0E-01	mg/kg-day	1.5E+00	
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	1.2E-02	mg/kg-day	2.4E-02	mg/kg-day	5.0E-01	
			Exp. Route Total									N/A					6.2E+00
			Dermal	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	5.8E-06	mg/kg-day	3.0E-04	mg/kg-day	1.9E-02	
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	1.2E-07	mg/kg-day	3.0E-04	mg/kg-day	4.1E-04	
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	2.8E-06	mg/kg-day	6.0E-04	mg/kg-day	4.6E-03	
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	6.4E-03	mg/kg-day	7.0E-01	mg/kg-day	9.1E-03	
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	7.1E-05	mg/kg-day	9.6E-04	mg/kg-day	7.4E-02	
			Exp. Route Total									N/A					1.1E-01
	Exposure Medium Total									N/A					6.4E+00		
Groundwater Total										N/A					6.4E+00		
Total of Receptor Risk											N/A	Total of Receptor Hazard				1.4E+01	

Notes-

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

DAevent for exposure to groundwater calculated on Table 7.8.RME Supplement A.

N/A = Not applicable.

Table 7.8.RME Supplement A  
Calculation of DAevent for Groundwater  
Adult Resident  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Water Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time ( $t_{event}$ ) (hr)	$t^*$ (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event ( $t_{event}$ ) (hr)	DAevent ( $mg/cm^2$ -event)	Eq
Arsenic	3.3E+01	1.0E-03	N/A	N/A	N/A	N/A	0.71	2.3E-08	1
Cobalt	1.7E+00	4.0E-04	N/A	N/A	N/A	N/A	0.71	5.0E-10	1
Cyanide	1.6E+01	1.0E-03	N/A	N/A	N/A	N/A	0.71	1.1E-08	1
Iron	3.6E+04	1.0E-03	N/A	N/A	N/A	N/A	0.71	2.6E-05	1
Manganese	4.0E+02	1.0E-03	N/A	N/A	N/A	N/A	0.71	2.8E-07	1

Notes:

N/A - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

$t^*$  - Time to reach steady-state

**Inorganics: DAevent ( $mg/cm^2$ -event) =**

$Kp \times CW \times t_{event} \times 0.001 \text{ mg}/\mu\text{g} \times 0.001 \text{ l}/\text{cm}^3$  (eq 1)

TABLE 7.9.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	2.5E-05	mg/kg-day	2.0E-03	mg/kg-day	1.3E-02		
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	4.8E-06	mg/kg-day	1.0E-04	mg/kg-day	4.8E-02		
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	3.3E-02	mg/kg-day	5.0E-04	mg/kg-day	6.6E+01		
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	4.4E-05	mg/kg-day	2.0E-03	mg/kg-day	2.2E-02		
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	6.1E-04	mg/kg-day	9.0E-04	mg/kg-day	6.8E-01		
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	5.8E-05	mg/kg-day	2.0E-03	mg/kg-day	2.9E-02		
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	1.3E-01	mg/kg-day	1.0E+00	mg/kg-day	1.3E-01		
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	7.5E-05	mg/kg-day	3.0E-04	mg/kg-day	2.5E-01		
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	1.2E-05	mg/kg-day	3.0E-03	mg/kg-day	4.0E-03		
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	3.4E-05	mg/kg-day	3.0E-04	mg/kg-day	1.1E-01		
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	2.0E-01	mg/kg-day	7.0E-01	mg/kg-day	2.8E-01		
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	1.5E-06	mg/kg-day	1.0E-05	mg/kg-day	1.5E-01		
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	3.0E-04	mg/kg-day	5.0E-03	mg/kg-day	6.1E-02		
				Exp. Route Total									N/A					6.7E+01
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	6.9E-06	mg/kg-day	2.0E-03	mg/kg-day	3.4E-03		
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	1.3E-06	mg/kg-day	1.0E-04	mg/kg-day	1.3E-02		
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	2.8E-03	mg/kg-day	5.0E-04	mg/kg-day	5.7E+00		
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	7.2E-07	mg/kg-day	2.0E-03	mg/kg-day	3.6E-04		
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	1.7E-04	mg/kg-day	9.0E-04	mg/kg-day	1.8E-01		
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	1.4E-06	mg/kg-day	2.0E-03	mg/kg-day	7.1E-04		
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	3.6E-03	mg/kg-day	1.0E+00	mg/kg-day	3.6E-03		
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	6.1E-06	mg/kg-day	3.0E-04	mg/kg-day	2.0E-02		
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	3.2E-07	mg/kg-day	7.5E-05	mg/kg-day	4.3E-03		
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	9.1E-07	mg/kg-day	3.0E-04	mg/kg-day	3.0E-03		
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	5.3E-03	mg/kg-day	7.0E-01	mg/kg-day	7.6E-03		
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	3.9E-08	mg/kg-day	1.0E-05	mg/kg-day	3.9E-03		
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	8.2E-06	mg/kg-day	1.3E-04	mg/kg-day	6.3E-02		
				Exp. Route Total									N/A					6.0E+00
			Exposure Point Total										N/A					7.3E+01
			Exposure Medium Total										N/A					7.3E+01
Surface and Subsurface Soil Total											N/A						7.3E+01	

TABLE 7.9.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	1.6E-03	mg/kg-day	3.0E-04	mg/kg-day	5.4E+00	
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	8.7E-05	mg/kg-day	3.0E-04	mg/kg-day	2.9E-01	
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	7.8E-04	mg/kg-day	6.0E-04	mg/kg-day	1.3E+00	
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	1.8E+00	mg/kg-day	7.0E-01	mg/kg-day	2.6E+00	
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	2.0E-02	mg/kg-day	2.4E-02	mg/kg-day	8.3E-01	
			Exp. Route Total									N/A					1.0E+01
			Dermal	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	7.2E-06	mg/kg-day	3.0E-04	mg/kg-day	2.4E-02	
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	1.5E-07	mg/kg-day	3.0E-04	mg/kg-day	5.1E-04	
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	3.4E-06	mg/kg-day	6.0E-04	mg/kg-day	5.7E-03	
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	7.9E-03	mg/kg-day	7.0E-01	mg/kg-day	1.1E-02	
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	8.8E-05	mg/kg-day	9.6E-04	mg/kg-day	9.2E-02	
			Exp. Route Total									N/A					1.3E-01
			Exposure Medium Total									N/A					1.1E+01
			Groundwater Total									N/A					1.1E+01
									Total of Receptor Risk			N/A	Total of Receptor Hazard				8.4E+01

Notes-

DAevent for exposure to groundwater calculated on Table 7.9.RME Supplement A.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

N/A = Not applicable.

Table 7.9.RME Supplement A  
Calculation of DAevent for Groundwater  
Child Resident  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Water Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (t <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	3.3E+01	1.0E-03	N/A	N/A	N/A	N/A	0.54	1.8E-08	1
Cobalt	1.7E+00	4.0E-04	N/A	N/A	N/A	N/A	0.54	3.8E-10	1
Cyanide	1.6E+01	1.0E-03	N/A	N/A	N/A	N/A	0.54	8.4E-09	1
Iron	3.6E+04	1.0E-03	N/A	N/A	N/A	N/A	0.54	1.9E-05	1
Manganese	4.0E+02	1.0E-03	N/A	N/A	N/A	N/A	0.54	2.2E-07	1

Notes:

N/A - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm<sup>3</sup> (eq 1)

TABLE 7.10.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations								
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient				
							Value	Units	Value	Units		Value	Units	Value	Units					
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	2.8E-06	mg/kg-day	3.1E-01	mg/kg-day	8.7E-07	N/A		N/A		N/A				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	5.4E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	3.7E-03	mg/kg-day	3.0E-02	mg/kg-day	1.1E-04	N/A		N/A		N/A				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	5.0E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2-Nitrotoluene	4.8E+01	mg/kg	6.9E-05	mg/kg-day	2.2E-01	mg/kg-day	1.5E-05	N/A		N/A		N/A				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	6.6E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Aluminum	1.1E+04	mg/kg	1.5E-02	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Arsenic	5.9E+00	mg/kg	8.5E-06	mg/kg-day	1.5E+00	mg/kg-day	1.3E-05	N/A		N/A		N/A				
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg			5.0E-01	mg/kg-day	3.1E-06	N/A		N/A		N/A				
				Cobalt	2.6E+00	mg/kg	3.8E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Iron	1.5E+04	mg/kg	2.2E-02	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Thallium	1.1E-01	mg/kg	1.6E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Vanadium	2.4E+01	mg/kg	3.4E-05	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Exp. Route Total											1.4E-04					N/A
			Dermal Absorption <sup>2</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	8.8E-07	mg/kg-day	3.1E-01	mg/kg-day	2.7E-07	N/A		N/A		N/A				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.7E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	3.6E-04	mg/kg-day	3.0E-02	mg/kg-day	1.1E-05	N/A		N/A		N/A				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	9.2E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2-Nitrotoluene	4.8E+01	mg/kg	2.1E-05	mg/kg-day	2.2E-01	mg/kg-day	4.6E-06	N/A		N/A		N/A				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	1.8E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Aluminum	1.1E+04	mg/kg	4.6E-04	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Arsenic	5.9E+00	mg/kg	7.8E-07	mg/kg-day	1.5E+00	mg/kg-day	1.2E-06	N/A		N/A		N/A				
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg			2.0E+01	mg/kg-day	3.5E-06	N/A		N/A		N/A				
				Cobalt	2.6E+00	mg/kg	1.2E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Iron	1.5E+04	mg/kg	6.8E-04	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Thallium	1.1E-01	mg/kg	5.0E-09	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Vanadium	2.4E+01	mg/kg	1.0E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Exp. Route Total											2.0E-05					N/A
			Exposure Point Total												1.6E-04					N/A
			Exposure Medium Total												1.6E-04					N/A
Surface and Subsurface Soil Total												1.6E-04					N/A			

TABLE 7.10.RME  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	4.2E-04	mg/kg-day	1.5E+00	1/mg/kg-day	6.3E-04	N/A		N/A		N/A		
				Cobalt	1.7E+00	ug/L	2.2E-05	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Cyanide	1.6E+01	ug/L	2.0E-04	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Iron	3.6E+04	ug/L	4.6E-01	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Manganese	4.0E+02	ug/L	5.2E-03	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
			Exp. Route Total										6.3E-04					N/A
			Dermal	Arsenic	3.3E+01	ug/L	2.3E-06	mg/kg-day	1.5E+00	1/mg/kg-day	3.4E-06	N/A		N/A		N/A		
				Cobalt	1.7E+00	ug/L	4.9E-08	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Cyanide	1.6E+01	ug/L	1.1E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Iron	3.6E+04	ug/L	2.5E-03	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
				Manganese	4.0E+02	ug/L	2.8E-05	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A		
			Exp. Route Total										3.4E-06					N/A
Exposure Medium Total										6.3E-04					N/A			
Groundwater Total										6.3E-04					N/A			
Total of Receptor Risk											8.0E-04	Total of Receptor Hazard				N/A		

Notes-

<sup>1</sup> See Table 7.10.RME Supplement A for calculation of intake and cancer risk following MMOA method.

<sup>2</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

DAevent for exposure to groundwater calculated on Tables 7.8.RME Supplement A and 7.9.RME Supplement A.

TABLE 7.10.RME Supplement A  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
					Value	Units	Intake				CSF/Unit Risk					Cancer Risk	
							Value				Units	Value					Units
							0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	Chromium (hexavalent)	9.4E-01	mg/kg	3.4E-07	6.9E-07	1.8E-07	1.8E-07	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	3.1E-06
			Dermal	Chromium (hexavalent)	9.4E-01	mg/kg	9.2E-09	1.8E-08	6.8E-09	6.8E-09	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.5E-06

Cancer risk = (Intake<sub>0-2</sub> x CSF<sub>0-2</sub>) + (Intake<sub>2-6</sub> x CSF<sub>2-6</sub>) + (Intake<sub>6-16</sub> x CSF<sub>6-16</sub>) + (Intake<sub>16-26</sub> x CSF<sub>16-26</sub>)

Notes:  
ADAF = Age-dependent adjustment factor  
CSF = Cancer slope factor  
EPC = Exposure point concentration  
mg/kg = milligram per kilogram  
mg/kg-day = milligram per kilogram per day

TABLE 7.1.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current

Receptor Population: Base Worker

Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	5.5E-08	mg/kg-day	3.1E-01	mg/kg-day	1.7E-08	4.3E-07	mg/kg-day	2.0E-03	mg/kg-day	2.1E-04		
				1,3-Dinitrobenzene	4.9E-01	mg/kg	2.4E-08	mg/kg-day	N/A		N/A	1.8E-07	mg/kg-day	1.0E-04	mg/kg-day	1.8E-03		
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	3.2E-04	mg/kg-day	3.0E-02	mg/kg-day	9.5E-06	2.5E-03	mg/kg-day	5.0E-04	mg/kg-day	4.9E+00		
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	2.0E-07	mg/kg-day	N/A		N/A	1.6E-06	mg/kg-day	2.0E-03	mg/kg-day	7.8E-04		
				2-Nitrotoluene	4.8E+01	mg/kg	2.3E-06	mg/kg-day	2.2E-01	mg/kg-day	5.1E-07	1.8E-05	mg/kg-day	9.0E-04	mg/kg-day	2.0E-02		
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	2.4E-07	mg/kg-day	N/A		N/A	1.9E-06	mg/kg-day	2.0E-03	mg/kg-day	9.5E-04		
				Aluminum	9.7E+03	mg/kg	4.7E-04	mg/kg-day	N/A		N/A	3.7E-03	mg/kg-day	1.0E+00	mg/kg-day	3.7E-03		
				Arsenic	4.9E+00	mg/kg	2.4E-07	mg/kg-day	1.5E+00	mg/kg-day	3.5E-07	1.8E-06	mg/kg-day	3.0E-04	mg/kg-day	6.1E-03		
				Cobalt	2.4E+00	mg/kg	1.1E-07	mg/kg-day	N/A		N/A	8.9E-07	mg/kg-day	3.0E-04	mg/kg-day	3.0E-03		
				Iron	1.6E+04	mg/kg	7.6E-04	mg/kg-day	N/A		N/A	5.9E-03	mg/kg-day	7.0E-01	mg/kg-day	8.5E-03		
				Thallium	1.1E-01	mg/kg	5.2E-09	mg/kg-day	N/A		N/A	4.1E-08	mg/kg-day	1.0E-05	mg/kg-day	4.1E-03		
				Vanadium	2.3E+01	mg/kg	1.1E-06	mg/kg-day	N/A		N/A	8.5E-06	mg/kg-day	5.0E-03	mg/kg-day	1.7E-03		
			Exp. Route Total										1.0E-05					5.0E+00
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	7.8E-09	mg/kg-day	3.1E-01	mg/kg-day	2.4E-09	6.0E-08	mg/kg-day	2.0E-03	mg/kg-day	3.0E-05		
				1,3-Dinitrobenzene	4.9E-01	mg/kg	3.3E-09	mg/kg-day	N/A		N/A	2.5E-08	mg/kg-day	1.0E-04	mg/kg-day	2.5E-04		
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.4E-05	mg/kg-day	3.0E-02	mg/kg-day	4.2E-07	1.1E-04	mg/kg-day	5.0E-04	mg/kg-day	2.2E-01		
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	1.7E-09	mg/kg-day	N/A		N/A	1.3E-08	mg/kg-day	2.0E-03	mg/kg-day	6.5E-06		
				2-Nitrotoluene	4.8E+01	mg/kg	3.2E-07	mg/kg-day	2.2E-01	mg/kg-day	7.1E-08	2.5E-06	mg/kg-day	9.0E-04	mg/kg-day	2.8E-03		
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	3.0E-09	mg/kg-day	N/A		N/A	2.4E-08	mg/kg-day	2.0E-03	mg/kg-day	1.2E-05		
				Aluminum	9.7E+03	mg/kg	6.5E-06	mg/kg-day	N/A		N/A	5.1E-05	mg/kg-day	1.0E+00	mg/kg-day	5.1E-05		
				Arsenic	4.9E+00	mg/kg	9.9E-09	mg/kg-day	1.5E+00	mg/kg-day	1.5E-08	7.7E-08	mg/kg-day	3.0E-04	mg/kg-day	2.6E-04		
				Cobalt	2.4E+00	mg/kg	1.6E-09	mg/kg-day	N/A		N/A	1.2E-08	mg/kg-day	3.0E-04	mg/kg-day	4.1E-05		
				Iron	1.6E+04	mg/kg	1.1E-05	mg/kg-day	N/A		N/A	8.2E-05	mg/kg-day	7.0E-01	mg/kg-day	1.2E-04		
				Thallium	1.1E-01	mg/kg	7.2E-11	mg/kg-day	N/A		N/A	5.6E-10	mg/kg-day	1.0E-05	mg/kg-day	5.6E-05		
				Vanadium	2.3E+01	mg/kg	1.5E-08	mg/kg-day	N/A		N/A	1.2E-07	mg/kg-day	1.3E-04	mg/kg-day	9.1E-04		
			Exp. Route Total										5.1E-07					2.2E-01
		Exposure Point Total											1.1E-05					5.2E+00
	Exposure Medium Total											1.1E-05					5.2E+00	
Surface Soil Total											1.1E-05					5.2E+00		
Total of Receptor Risks Across All Media											1.1E-05	Total of Receptor Hazards Across All Media				5.2E+00		

Notes:

N/A =Not available; Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.2.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current

Receptor Population: Recreational User

Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	2.6E-09	mg/kg-day	3.1E-01	mg/kg-day	8.1E-10	2.0E-08	mg/kg-day	2.0E-03	mg/kg-day	1.0E-05	
				1,3-Dinitrobenzene	4.9E-01	mg/kg	1.1E-09	mg/kg-day	N/A		N/A	8.7E-09	mg/kg-day	1.0E-04	mg/kg-day	8.7E-05	
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.5E-05	mg/kg-day	3.0E-02	mg/kg-day	4.5E-07	1.2E-04	mg/kg-day	5.0E-04	mg/kg-day	2.3E-01	
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	9.5E-09	mg/kg-day	N/A		N/A	7.4E-08	mg/kg-day	2.0E-03	mg/kg-day	3.7E-05	
				2-Nitrotoluene	4.8E+01	mg/kg	1.1E-07	mg/kg-day	2.2E-01	mg/kg-day	2.4E-08	8.5E-07	mg/kg-day	9.0E-04	mg/kg-day	9.5E-04	
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	1.2E-08	mg/kg-day	N/A		N/A	9.0E-08	mg/kg-day	2.0E-03	mg/kg-day	4.5E-05	
				Aluminum	9.7E+03	mg/kg	2.2E-05	mg/kg-day	N/A		N/A	1.7E-04	mg/kg-day	1.0E+00	mg/kg-day	1.7E-04	
				Arsenic	4.9E+00	mg/kg	1.1E-08	mg/kg-day	1.5E+00	mg/kg-day	1.7E-08	8.7E-08	mg/kg-day	3.0E-04	mg/kg-day	2.9E-04	
				Cobalt	2.4E+00	mg/kg	5.4E-09	mg/kg-day	N/A		N/A	4.2E-08	mg/kg-day	3.0E-04	mg/kg-day	1.4E-04	
				Iron	1.6E+04	mg/kg	3.6E-05	mg/kg-day	N/A		N/A	2.8E-04	mg/kg-day	7.0E-01	mg/kg-day	4.0E-04	
				Thallium	1.1E-01	mg/kg	2.5E-10	mg/kg-day	N/A		N/A	1.9E-09	mg/kg-day	1.0E-05	mg/kg-day	1.9E-04	
				Vanadium	2.3E+01	mg/kg	5.2E-08	mg/kg-day	N/A		N/A	4.0E-07	mg/kg-day	5.0E-03	mg/kg-day	8.1E-05	
			Exp. Route Total									4.9E-07					2.4E-01
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	8.0E-10	mg/kg-day	3.1E-01	mg/kg-day	2.5E-10	6.2E-09	mg/kg-day	2.0E-03	mg/kg-day	3.1E-06	
				1,3-Dinitrobenzene	4.9E-01	mg/kg	3.4E-10	mg/kg-day	N/A		N/A	2.6E-09	mg/kg-day	1.0E-04	mg/kg-day	2.6E-05	
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.5E-06	mg/kg-day	3.0E-02	mg/kg-day	4.4E-08	1.1E-05	mg/kg-day	5.0E-04	mg/kg-day	2.3E-02	
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	1.7E-10	mg/kg-day	N/A		N/A	1.3E-09	mg/kg-day	2.0E-03	mg/kg-day	6.7E-07	
				2-Nitrotoluene	4.8E+01	mg/kg	3.3E-08	mg/kg-day	2.2E-01	mg/kg-day	7.3E-09	2.6E-07	mg/kg-day	9.0E-04	mg/kg-day	2.9E-04	
		4-Amino-2,6-dinitrotoluene		5.1E+00	mg/kg	3.1E-10	mg/kg-day	N/A		N/A	2.4E-09	mg/kg-day	2.0E-03	mg/kg-day	1.2E-06		
		Aluminum		9.7E+03	mg/kg	6.7E-07	mg/kg-day	N/A		N/A	5.2E-06	mg/kg-day	1.0E+00	mg/kg-day	5.2E-06		
		Arsenic		4.9E+00	mg/kg	1.0E-09	mg/kg-day	1.5E+00	mg/kg-day	1.5E-09	7.9E-09	mg/kg-day	3.0E-04	mg/kg-day	2.6E-05		
		Cobalt		2.4E+00	mg/kg	1.6E-10	mg/kg-day	N/A		N/A	1.3E-09	mg/kg-day	3.0E-04	mg/kg-day	4.2E-06		
		Iron		1.6E+04	mg/kg	1.1E-06	mg/kg-day	N/A		N/A	8.5E-06	mg/kg-day	7.0E-01	mg/kg-day	1.2E-05		
		Thallium	1.1E-01	mg/kg	7.5E-12	mg/kg-day	N/A		N/A	5.8E-11	mg/kg-day	1.0E-05	mg/kg-day	5.8E-06			
		Vanadium	2.3E+01	mg/kg	1.6E-09	mg/kg-day	N/A		N/A	1.2E-08	mg/kg-day	1.3E-04	mg/kg-day	9.4E-05			
		Exp. Route Total									5.3E-08					2.3E-02	
		Exposure Point Total										5.5E-07					2.6E-01
		Exposure Medium Total										5.5E-07					2.6E-01
Surface Soil Total											5.5E-07					2.6E-01	
Total of Receptor Risks Across All Media											5.5E-07	Total of Receptor Hazards Across All Media				2.6E-01	

Notes:

N/A =Not available; Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil and sediment are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.3.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Soil	Surface Soil	Surface Soil	Ingestion	2,4-Dinitrotoluene	1.1E+00	mg/kg	2.2E-08	mg/kg-day	3.1E-01	mg/kg-day	6.7E-09	2.5E-07	mg/kg-day	2.0E-03	mg/kg-day	1.3E-04
				1,3-Dinitrobenzene	4.9E-01	mg/kg	9.3E-09	mg/kg-day	N/A		N/A	1.1E-07	mg/kg-day	1.0E-04	mg/kg-day	1.1E-03
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	1.3E-04	mg/kg-day	3.0E-02	mg/kg-day	3.8E-06	1.5E-03	mg/kg-day	5.0E-04	mg/kg-day	2.9E+00
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	7.9E-08	mg/kg-day	N/A		N/A	9.2E-07	mg/kg-day	2.0E-03	mg/kg-day	4.6E-04
				2-Nitrotoluene	4.8E+01	mg/kg	9.2E-07	mg/kg-day	2.2E-01	mg/kg-day	2.0E-07	1.1E-05	mg/kg-day	9.0E-04	mg/kg-day	1.2E-02
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	9.7E-08	mg/kg-day	N/A		N/A	1.1E-06	mg/kg-day	2.0E-03	mg/kg-day	5.6E-04
				Aluminum	9.7E+03	mg/kg	1.9E-04	mg/kg-day	N/A		N/A	2.2E-03	mg/kg-day	1.0E+00	mg/kg-day	2.2E-03
				Arsenic	4.9E+00	mg/kg	9.4E-08	mg/kg-day	1.5E+00	mg/kg-day	1.4E-07	1.1E-06	mg/kg-day	3.0E-04	mg/kg-day	3.7E-03
				Cobalt	2.4E+00	mg/kg	4.5E-08	mg/kg-day	N/A		N/A	5.3E-07	mg/kg-day	3.0E-04	mg/kg-day	1.8E-03
				Iron	1.6E+04	mg/kg	3.0E-04	mg/kg-day	N/A		N/A	3.5E-03	mg/kg-day	7.0E-01	mg/kg-day	5.0E-03
				Thallium	1.1E-01	mg/kg	2.1E-09	mg/kg-day	N/A		N/A	2.4E-08	mg/kg-day	1.0E-05	mg/kg-day	2.4E-03
				Vanadium	2.3E+01	mg/kg	4.3E-07	mg/kg-day	N/A		N/A	5.1E-06	mg/kg-day	5.0E-03	mg/kg-day	1.0E-03
			Exp. Route Total								4.1E-06					3.0E+00
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	1.1E+00	mg/kg	5.1E-09	mg/kg-day	3.1E-01	mg/kg-day	1.6E-09	5.9E-08	mg/kg-day	2.0E-03	mg/kg-day	3.0E-05
				1,3-Dinitrobenzene	4.9E-01	mg/kg	2.1E-09	mg/kg-day	N/A		N/A	2.5E-08	mg/kg-day	1.0E-04	mg/kg-day	2.5E-04
				2,4,6-Trinitrotoluene	6.6E+03	mg/kg	9.2E-06	mg/kg-day	3.0E-02	mg/kg-day	2.8E-07	1.1E-04	mg/kg-day	5.0E-04	mg/kg-day	2.1E-01
				2-Amino-4,6-dinitrotoluene	4.1E+00	mg/kg	1.1E-09	mg/kg-day	N/A		N/A	1.3E-08	mg/kg-day	2.0E-03	mg/kg-day	6.3E-06
				2-Nitrotoluene	4.8E+01	mg/kg	2.1E-07	mg/kg-day	2.2E-01	mg/kg-day	4.6E-08	2.5E-06	mg/kg-day	9.0E-04	mg/kg-day	2.7E-03
				4-Amino-2,6-dinitrotoluene	5.1E+00	mg/kg	2.0E-09	mg/kg-day	N/A		N/A	2.3E-08	mg/kg-day	2.0E-03	mg/kg-day	1.2E-05
				Aluminum	9.7E+03	mg/kg	4.3E-06	mg/kg-day	N/A		N/A	5.0E-05	mg/kg-day	1.0E+00	mg/kg-day	5.0E-05
				Arsenic	4.9E+00	mg/kg	6.4E-09	mg/kg-day	1.5E+00	mg/kg-day	9.7E-09	7.5E-08	mg/kg-day	3.0E-04	mg/kg-day	2.5E-04
				Cobalt	2.4E+00	mg/kg	1.0E-09	mg/kg-day	N/A		N/A	1.2E-08	mg/kg-day	3.0E-04	mg/kg-day	4.0E-05
				Iron	1.6E+04	mg/kg	6.9E-06	mg/kg-day	N/A		N/A	8.1E-05	mg/kg-day	7.0E-01	mg/kg-day	1.2E-04
				Thallium	1.1E-01	mg/kg	4.7E-11	mg/kg-day	N/A		N/A	5.5E-10	mg/kg-day	1.0E-05	mg/kg-day	5.5E-05
				Vanadium	2.3E+01	mg/kg	9.9E-09	mg/kg-day	N/A		N/A	1.2E-07	mg/kg-day	1.3E-04	mg/kg-day	8.9E-04
			Exp. Route Total								3.3E-07					2.2E-01
		Exposure Point Total									4.4E-06					3.2E+00
	Exposure Medium Total									4.4E-06					3.2E+00	
Surface Soil Total											4.4E-06					3.2E+00
Total of Receptor Risks Across All Media											4.4E-06	Total of Receptor Hazards Across All Media				3.2E+00

Notes:

N/A =Not available; Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil and sediment are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.4.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations								
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient				
							Value	Units	Value	Units		Value	Units	Value	Units					
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	9.5E-08	mg/kg-day	3.1E-01	mg/kg-day	2.9E-08	7.4E-07	mg/kg-day	2.0E-03	mg/kg-day	3.7E-04				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.8E-08	mg/kg-day	N/A		N/A	1.4E-07	mg/kg-day	1.0E-04	mg/kg-day	1.4E-03				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	1.2E-04	mg/kg-day	3.0E-02	mg/kg-day	3.7E-06	9.6E-04	mg/kg-day	5.0E-04	mg/kg-day	1.9E+00				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	1.7E-07	mg/kg-day	N/A		N/A	1.3E-06	mg/kg-day	2.0E-03	mg/kg-day	6.5E-04				
				2-Nitrotoluene	4.8E+01	mg/kg	2.3E-06	mg/kg-day	2.2E-01	mg/kg-day	5.1E-07	1.8E-05	mg/kg-day	9.0E-04	mg/kg-day	2.0E-02				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	2.2E-07	mg/kg-day	N/A		N/A	1.7E-06	mg/kg-day	2.0E-03	mg/kg-day	8.6E-04				
				Aluminum	1.1E+04	mg/kg	5.1E-04	mg/kg-day	N/A		N/A	3.9E-03	mg/kg-day	1.0E+00	mg/kg-day	3.9E-03				
				Arsenic	5.9E+00	mg/kg	2.8E-07	mg/kg-day	1.5E+00	mg/kg-day	4.3E-07	2.2E-06	mg/kg-day	3.0E-04	mg/kg-day	7.4E-03				
				Chromium (hexavalent)	9.4E-01	mg/kg	4.5E-08	mg/kg-day	5.0E-01	mg/kg-day	2.3E-08	3.5E-07	mg/kg-day	3.0E-03	mg/kg-day	1.2E-04				
				Cobalt	2.6E+00	mg/kg	1.3E-07	mg/kg-day	N/A		N/A	9.9E-07	mg/kg-day	3.0E-04	mg/kg-day	3.3E-03				
				Iron	1.5E+04	mg/kg	7.4E-04	mg/kg-day	N/A		N/A	5.8E-03	mg/kg-day	7.0E-01	mg/kg-day	8.2E-03				
				Thallium	1.1E-01	mg/kg	5.5E-09	mg/kg-day	N/A		N/A	4.3E-08	mg/kg-day	1.0E-05	mg/kg-day	4.3E-03				
				Vanadium	2.4E+01	mg/kg	1.1E-06	mg/kg-day	N/A		N/A	8.9E-06	mg/kg-day	5.0E-03	mg/kg-day	1.8E-03				
				Exp. Route Total											4.7E-06					2.0E+00
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	1.3E-08	mg/kg-day	3.1E-01	mg/kg-day	4.2E-09	1.0E-07	mg/kg-day	2.0E-03	mg/kg-day	5.2E-05				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	2.5E-09	mg/kg-day	N/A		N/A	2.0E-08	mg/kg-day	1.0E-04	mg/kg-day	2.0E-04				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	5.5E-06	mg/kg-day	3.0E-02	mg/kg-day	1.7E-07	4.3E-05	mg/kg-day	5.0E-04	mg/kg-day	8.6E-02				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	1.4E-09	mg/kg-day	N/A		N/A	1.1E-08	mg/kg-day	2.0E-03	mg/kg-day	5.4E-06				
				2-Nitrotoluene	4.8E+01	mg/kg	3.2E-07	mg/kg-day	2.2E-01	mg/kg-day	7.1E-08	2.5E-06	mg/kg-day	9.0E-04	mg/kg-day	2.8E-03				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	2.8E-09	mg/kg-day	N/A		N/A	2.1E-08	mg/kg-day	2.0E-03	mg/kg-day	1.1E-05				
				Aluminum	1.1E+04	mg/kg	7.0E-06	mg/kg-day	N/A		N/A	5.5E-05	mg/kg-day	1.0E+00	mg/kg-day	5.5E-05				
				Arsenic	5.9E+00	mg/kg	1.2E-08	mg/kg-day	1.5E+00	mg/kg-day	1.8E-08	9.2E-08	mg/kg-day	3.0E-04	mg/kg-day	3.1E-04				
				Chromium (hexavalent)	9.4E-01	mg/kg	6.3E-10	mg/kg-day	2.0E+01	mg/kg-day	1.3E-08	4.9E-09	mg/kg-day	7.5E-05	mg/kg-day	6.5E-05				
				Cobalt	2.6E+00	mg/kg	1.8E-09	mg/kg-day	N/A		N/A	1.4E-08	mg/kg-day	3.0E-04	mg/kg-day	4.6E-05				
				Iron	1.5E+04	mg/kg	1.0E-05	mg/kg-day	N/A		N/A	8.0E-05	mg/kg-day	7.0E-01	mg/kg-day	1.1E-04				
				Thallium	1.1E-01	mg/kg	7.6E-11	mg/kg-day	N/A		N/A	5.9E-10	mg/kg-day	1.0E-05	mg/kg-day	5.9E-05				
				Vanadium	2.4E+01	mg/kg	1.6E-08	mg/kg-day	N/A		N/A	1.2E-07	mg/kg-day	1.3E-04	mg/kg-day	9.5E-04				
				Exp. Route Total											2.7E-07					9.0E-02
			Exposure Point Total												5.0E-06					2.1E+00
			Exposure Medium Total												5.0E-06					2.1E+00
Surface and Subsurface Soil Total												5.0E-06					2.1E+00			

TABLE 7.4.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future

Receptor Population: Base Worker

Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	1.6E-05	mg/kg-day	1.5E+00	1/mg/kg-day	2.4E-05	1.2E-04	mg/kg-day	3.0E-04	mg/kg-day	4.1E-01
				Cobalt	1.7E+00	ug/L	8.4E-07	mg/kg-day	N/A	1/mg/kg-day	N/A	6.5E-06	mg/kg-day	3.0E-04	mg/kg-day	2.2E-02
				Cyanide	1.6E+01	ug/L	7.5E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	5.9E-05	mg/kg-day	6.0E-04	mg/kg-day	9.8E-02
				Iron	3.6E+04	ug/L	1.7E-02	mg/kg-day	N/A	1/mg/kg-day	N/A	1.4E-01	mg/kg-day	7.0E-01	mg/kg-day	1.9E-01
				Manganese	4.0E+02	ug/L	1.9E-04	mg/kg-day	N/A	1/mg/kg-day	N/A	1.5E-03	mg/kg-day	2.4E-02	mg/kg-day	6.3E-02
			Exp. Route Total							2.4E-05					7.8E-01	
	Exposure Medium Total						2.4E-05					7.8E-01				
Groundwater Total								2.4E-05					7.8E-01			
Total of Receptor Risk											2.9E-05	Total of Receptor Hazard				2.9E+00

Notes-

N/A = Not applicable.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives, DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.5.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	3.8E-08	mg/kg-day	3.1E-01	mg/kg-day	1.2E-08	4.4E-07	mg/kg-day	2.0E-03	mg/kg-day	2.2E-04
				1,3-Dinitrobenzene	3.8E-01	mg/kg	7.2E-09	mg/kg-day	N/A		N/A	8.4E-08	mg/kg-day	1.0E-04	mg/kg-day	8.4E-04
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	4.9E-05	mg/kg-day	3.0E-02	mg/kg-day	1.5E-06	5.7E-04	mg/kg-day	5.0E-04	mg/kg-day	1.1E+00
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	6.6E-08	mg/kg-day	N/A		N/A	7.7E-07	mg/kg-day	2.0E-03	mg/kg-day	3.9E-04
				2-Nitrotoluene	4.8E+01	mg/kg	9.2E-07	mg/kg-day	2.2E-01	mg/kg-day	2.0E-07	1.1E-05	mg/kg-day	9.0E-04	mg/kg-day	1.2E-02
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	8.7E-08	mg/kg-day	N/A		N/A	1.0E-06	mg/kg-day	2.0E-03	mg/kg-day	5.1E-04
				Aluminum	1.1E+04	mg/kg	2.0E-04	mg/kg-day	N/A		N/A	2.3E-03	mg/kg-day	1.0E+00	mg/kg-day	2.3E-03
				Arsenic	5.9E+00	mg/kg	1.1E-07	mg/kg-day	1.5E+00	mg/kg-day	1.7E-07	1.3E-06	mg/kg-day	3.0E-04	mg/kg-day	4.4E-03
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg			5.0E-01	mg/kg-day	4.8E-08	2.1E-07	mg/kg-day	3.0E-03	mg/kg-day	7.0E-05
				Cobalt	2.6E+00	mg/kg	5.0E-08	mg/kg-day	N/A		N/A	5.9E-07	mg/kg-day	3.0E-04	mg/kg-day	2.0E-03
				Iron	1.5E+04	mg/kg	2.9E-04	mg/kg-day	N/A		N/A	3.4E-03	mg/kg-day	7.0E-01	mg/kg-day	4.9E-03
				Thallium	1.1E-01	mg/kg	2.2E-09	mg/kg-day	N/A		N/A	2.5E-08	mg/kg-day	1.0E-05	mg/kg-day	2.5E-03
				Vanadium	2.4E+01	mg/kg	4.6E-07	mg/kg-day	N/A		N/A	5.3E-06	mg/kg-day	5.0E-03	mg/kg-day	1.1E-03
			Exp. Route Total							1.9E-06					1.2E+00	
			Dermal Absorption <sup>2</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	8.8E-09	mg/kg-day	3.1E-01	mg/kg-day	2.7E-09	1.0E-07	mg/kg-day	2.0E-03	mg/kg-day	5.1E-05
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.6E-09	mg/kg-day	N/A		N/A	1.9E-08	mg/kg-day	1.0E-04	mg/kg-day	1.9E-04
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	3.6E-06	mg/kg-day	3.0E-02	mg/kg-day	1.1E-07	4.2E-05	mg/kg-day	5.0E-04	mg/kg-day	8.4E-02
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	9.1E-10	mg/kg-day	N/A		N/A	1.1E-08	mg/kg-day	2.0E-03	mg/kg-day	5.3E-06
				2-Nitrotoluene	4.8E+01	mg/kg	2.1E-07	mg/kg-day	2.2E-01	mg/kg-day	4.6E-08	2.5E-06	mg/kg-day	9.0E-04	mg/kg-day	2.7E-03
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	1.8E-09	mg/kg-day	N/A		N/A	2.1E-08	mg/kg-day	2.0E-03	mg/kg-day	1.1E-05
				Aluminum	1.1E+04	mg/kg	4.6E-06	mg/kg-day	N/A		N/A	5.4E-05	mg/kg-day	1.0E+00	mg/kg-day	5.4E-05
				Arsenic	5.9E+00	mg/kg	7.7E-09	mg/kg-day	1.5E+00	mg/kg-day	1.2E-08	9.0E-08	mg/kg-day	3.0E-04	mg/kg-day	3.0E-04
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg			2.0E+01	mg/kg-day	4.4E-08	4.8E-09	mg/kg-day	7.5E-05	mg/kg-day	6.4E-05
				Cobalt	2.6E+00	mg/kg	1.2E-09	mg/kg-day	N/A		N/A	1.3E-08	mg/kg-day	3.0E-04	mg/kg-day	4.5E-05
				Iron	1.5E+04	mg/kg	6.7E-06	mg/kg-day	N/A		N/A	7.9E-05	mg/kg-day	7.0E-01	mg/kg-day	1.1E-04
				Thallium	1.1E-01	mg/kg	5.0E-11	mg/kg-day	N/A		N/A	5.8E-10	mg/kg-day	1.0E-05	mg/kg-day	5.8E-05
				Vanadium	2.4E+01	mg/kg	1.0E-08	mg/kg-day	N/A		N/A	1.2E-07	mg/kg-day	1.3E-04	mg/kg-day	9.4E-04
			Exp. Route Total							2.1E-07					8.9E-02	
			Exposure Point Total								2.1E-06					1.3E+00
			Exposure Medium Total								2.1E-06					1.3E+00
Surface and Subsurface Soil Total										2.1E-06					1.3E+00	
						Total of Receptor Risk				2.1E-06	Total of Receptor Hazard				1.3E+00	

Notes-

N/A = Not applicable.

<sup>1</sup> See Table 7.5.CTE Supplement A for calculation of intake and cancer risk following MMOA method.

<sup>2</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives, DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.5.CTE Supplement A  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						
					Value	Units	Intake			CSF/Unit Risk			Cancer Risk
							Value		Units	Value		Units	
							0-2 yrs	2-6 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	Chromium (hexavalent)	9.4E-01	mg/kg	6.0E-09	1.2E-08	mg/kg-day	5.0E+00	1.5E+00	1/(mg/kg-day)	4.8E-08
			Dermal	Chromium (hexavalent)	9.4E-01	mg/kg	1.4E-10	2.7E-10	mg/kg-day	2.0E+02	6.0E+01	1/(mg/kg-day)	4.4E-08

$$\text{Cancer risk} = (\text{Intake}_{0-2} \times \text{CSF}_{0-2}) + (\text{Intake}_{2-6} \times \text{CSF}_{2-6})$$

Notes:  
ADAF = Age-dependent adjustment factor  
CSF = Cancer slope factor  
EPC = Exposure point concentration  
mg/kg = milligram per kilogram  
mg/kg/day = milligram per kilogram per day

TABLE 7.6.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	1.2E-08	mg/kg-day	3.1E-01	mg/kg-day	3.7E-09	8.4E-07	mg/kg-day	7.0E-03	mg/kg-day	1.2E-04	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	2.3E-09	mg/kg-day	N/A		N/A	1.6E-07	mg/kg-day	5.0E-04	mg/kg-day	3.2E-04	
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	1.6E-05	mg/kg-day	3.0E-02	mg/kg-day	4.7E-07	1.1E-03	mg/kg-day	5.0E-04	mg/kg-day	2.2E+00	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	2.1E-08	mg/kg-day	N/A		N/A	1.5E-06	mg/kg-day	2.0E-03	mg/kg-day	7.4E-04	
				2-Nitrotoluene	4.8E+01	mg/kg	2.9E-07	mg/kg-day	2.2E-01	mg/kg-day	6.5E-08	2.1E-05	mg/kg-day	1.0E-02	mg/kg-day	2.1E-03	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	2.8E-08	mg/kg-day	N/A		N/A	2.0E-06	mg/kg-day	2.0E-03	mg/kg-day	9.8E-04	
				Aluminum	1.1E+04	mg/kg	6.4E-05	mg/kg-day	N/A		N/A	4.5E-03	mg/kg-day	1.0E+00	mg/kg-day	4.5E-03	
				Arsenic	5.9E+00	mg/kg	3.6E-08	mg/kg-day	1.5E+00	mg/kg-day	5.4E-08	2.5E-06	mg/kg-day	3.0E-04	mg/kg-day	8.4E-03	
				Chromium (hexavalent)	9.4E-01	mg/kg	5.7E-09	mg/kg-day	5.0E-01	mg/kg-day	2.9E-09	4.0E-07	mg/kg-day	5.0E-03	mg/kg-day	8.0E-05	
				Cobalt	2.6E+00	mg/kg	1.6E-08	mg/kg-day	N/A		N/A	1.1E-06	mg/kg-day	3.0E-03	mg/kg-day	3.8E-04	
				Iron	1.5E+04	mg/kg	9.4E-05	mg/kg-day	N/A		N/A	6.6E-03	mg/kg-day	7.0E-01	mg/kg-day	9.4E-03	
				Thallium	1.1E-01	mg/kg	7.0E-10	mg/kg-day	N/A		N/A	4.9E-08	mg/kg-day	4.0E-05	mg/kg-day	1.2E-03	
				Vanadium	2.4E+01	mg/kg	1.5E-07	mg/kg-day	N/A		N/A	1.0E-05	mg/kg-day	1.0E-02	mg/kg-day	1.0E-03	
				Exp. Route Total									6.0E-07				
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	4.2E-09	mg/kg-day	3.1E-01	mg/kg-day	1.3E-09	3.0E-07	mg/kg-day	7.0E-03	mg/kg-day	4.2E-05	
				1,3-Dinitrobenzene	3.8E-01	mg/kg	8.0E-10	mg/kg-day	N/A		N/A	5.6E-08	mg/kg-day	5.0E-04	mg/kg-day	1.1E-04	
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	1.7E-06	mg/kg-day	3.0E-02	mg/kg-day	5.2E-08	1.2E-04	mg/kg-day	5.0E-04	mg/kg-day	2.4E-01	
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	4.4E-10	mg/kg-day	N/A		N/A	3.1E-08	mg/kg-day	2.0E-03	mg/kg-day	1.5E-05	
				2-Nitrotoluene	4.8E+01	mg/kg	1.0E-07	mg/kg-day	2.2E-01	mg/kg-day	2.2E-08	7.1E-06	mg/kg-day	1.0E-02	mg/kg-day	7.1E-04	
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	8.7E-10	mg/kg-day	N/A		N/A	6.1E-08	mg/kg-day	2.0E-03	mg/kg-day	3.1E-05	
				Aluminum	1.1E+04	mg/kg	2.2E-06	mg/kg-day	N/A		N/A	1.6E-04	mg/kg-day	1.0E+00	mg/kg-day	1.6E-04	
				Arsenic	5.9E+00	mg/kg	3.8E-09	mg/kg-day	1.5E+00	mg/kg-day	5.6E-09	2.6E-07	mg/kg-day	3.0E-04	mg/kg-day	8.8E-04	
				Chromium (hexavalent)	9.4E-01	mg/kg	2.0E-10	mg/kg-day	2.0E+01	mg/kg-day	4.0E-09	1.4E-08	mg/kg-day	1.3E-04	mg/kg-day	1.1E-04	
				Cobalt	2.6E+00	mg/kg	5.6E-10	mg/kg-day	N/A		N/A	3.9E-08	mg/kg-day	3.0E-03	mg/kg-day	1.3E-05	
				Iron	1.5E+04	mg/kg	3.3E-06	mg/kg-day	N/A		N/A	2.3E-04	mg/kg-day	7.0E-01	mg/kg-day	3.3E-04	
				Thallium	1.1E-01	mg/kg	2.4E-11	mg/kg-day	N/A		N/A	1.7E-09	mg/kg-day	4.0E-05	mg/kg-day	4.2E-05	
				Vanadium	2.4E+01	mg/kg	5.1E-09	mg/kg-day	N/A		N/A	3.5E-07	mg/kg-day	2.6E-04	mg/kg-day	1.4E-03	
				Exp. Route Total									8.6E-08				
		Exposure Point Total									6.8E-07					2.5E+00	
		Exposure Medium Total									6.8E-07					2.5E+00	
Surface and Subsurface Soil Total												6.8E-07					2.5E+00
Total of Receptor Risk											6.8E-07	Total of Receptor Hazard				2.5E+00	

Notes-  
N/A = Not applicable.  
<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives, DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

TABLE 7.7.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations								
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient				
							Value	Units	Value	Units		Value	Units	Value	Units					
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	4.7E-07	mg/kg-day	2.0E-03	mg/kg-day	2.4E-04				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	9.0E-08	mg/kg-day	1.0E-04	mg/kg-day	9.0E-04				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	6.2E-04	mg/kg-day	5.0E-04	mg/kg-day	1.2E+00				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	8.3E-07	mg/kg-day	2.0E-03	mg/kg-day	4.2E-04				
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	1.2E-05	mg/kg-day	9.0E-04	mg/kg-day	1.3E-02				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	1.1E-06	mg/kg-day	2.0E-03	mg/kg-day	5.5E-04				
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	2.5E-03	mg/kg-day	1.0E+00	mg/kg-day	2.5E-03				
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	1.4E-06	mg/kg-day	3.0E-04	mg/kg-day	4.7E-03				
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	2.3E-07	mg/kg-day	3.0E-03	mg/kg-day	7.5E-05				
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	6.3E-07	mg/kg-day	3.0E-04	mg/kg-day	2.1E-03				
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	3.7E-03	mg/kg-day	7.0E-01	mg/kg-day	5.3E-03				
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	2.7E-08	mg/kg-day	1.0E-05	mg/kg-day	2.7E-03				
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	5.7E-06	mg/kg-day	5.0E-03	mg/kg-day	1.1E-03				
				Exp. Route Total											N/A					1.3E+00
				Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	1.4E-07	mg/kg-day	2.0E-03	mg/kg-day	7.2E-05			
			1,3-Dinitrobenzene		3.8E-01	mg/kg	N/A		N/A		N/A	2.7E-08	mg/kg-day	1.0E-04	mg/kg-day	2.7E-04				
			2,4,6-Trinitrotoluene		2.6E+03	mg/kg	N/A		N/A		N/A	5.9E-05	mg/kg-day	5.0E-04	mg/kg-day	1.2E-01				
			2-Amino-4,6-dinitrotoluene		3.5E+00	mg/kg	N/A		N/A		N/A	1.5E-08	mg/kg-day	2.0E-03	mg/kg-day	7.5E-06				
			2-Nitrotoluene		4.8E+01	mg/kg	N/A		N/A		N/A	3.5E-06	mg/kg-day	9.0E-04	mg/kg-day	3.9E-03				
			4-Amino-2,6-dinitrotoluene		4.6E+00	mg/kg	N/A		N/A		N/A	3.0E-08	mg/kg-day	2.0E-03	mg/kg-day	1.5E-05				
			Aluminum		1.1E+04	mg/kg	N/A		N/A		N/A	7.6E-05	mg/kg-day	1.0E+00	mg/kg-day	7.6E-05				
			Arsenic		5.9E+00	mg/kg	N/A		N/A		N/A	1.3E-07	mg/kg-day	3.0E-04	mg/kg-day	4.3E-04				
			Chromium (hexavalent)		9.4E-01	mg/kg	N/A		N/A		N/A	6.8E-09	mg/kg-day	7.5E-05	mg/kg-day	9.1E-05				
			Cobalt		2.6E+00	mg/kg	N/A		N/A		N/A	1.9E-08	mg/kg-day	3.0E-04	mg/kg-day	6.4E-05				
			Iron		1.5E+04	mg/kg	N/A		N/A		N/A	1.1E-04	mg/kg-day	7.0E-01	mg/kg-day	1.6E-04				
			Thallium		1.1E-01	mg/kg	N/A		N/A		N/A	8.2E-10	mg/kg-day	1.0E-05	mg/kg-day	8.2E-05				
			Vanadium		2.4E+01	mg/kg	N/A		N/A		N/A	1.7E-07	mg/kg-day	1.3E-04	mg/kg-day	1.3E-03				
			Exp. Route Total												N/A					1.3E-01
			Exposure Point Total												N/A					1.4E+00
			Exposure Medium Total												N/A					1.4E+00
Surface and Subsurface Soil Total												N/A					1.4E+00			

TABLE 7.7.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	3.9E-04	mg/kg-day	3.0E-04	mg/kg-day	1.3E+00
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	2.1E-05	mg/kg-day	3.0E-04	mg/kg-day	6.9E-02
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	1.9E-04	mg/kg-day	6.0E-04	mg/kg-day	3.1E-01
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	4.3E-01	mg/kg-day	7.0E-01	mg/kg-day	6.1E-01
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	4.7E-03	mg/kg-day	2.4E-02	mg/kg-day	2.0E-01
			Exp. Route Total						N/A				2.5E+00			
			Dermal	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	2.3E-06	mg/kg-day	3.0E-04	mg/kg-day	7.6E-03
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	4.9E-08	mg/kg-day	3.0E-04	mg/kg-day	1.6E-04
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	1.1E-06	mg/kg-day	6.0E-04	mg/kg-day	1.8E-03
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	2.5E-03	mg/kg-day	7.0E-01	mg/kg-day	3.6E-03
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	2.8E-05	mg/kg-day	9.6E-04	mg/kg-day	2.9E-02
			Exp. Route Total						N/A				4.2E-02			
	Exposure Medium Total									N/A				2.5E+00		
Groundwater Total									N/A				2.5E+00			
Total of Receptor Risk											N/A	Total of Receptor Hazard				3.9E+00

Notes-

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

DAevent for exposure to groundwater calculated on Table 7.7.CTE Supplement A.

N/A = Not applicable.

Table 7.7.CTE Supplement A  
Calculation of DAevent for Groundwater  
Adult Resident  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Water Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (t <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	3.3E+01	1.0E-03	N/A	N/A	N/A	N/A	0.28	9.1E-09	1
Cobalt	1.7E+00	4.0E-04	N/A	N/A	N/A	N/A	0.28	2.0E-10	1
Cyanide	1.6E+01	1.0E-03	N/A	N/A	N/A	N/A	0.28	4.4E-09	1
Iron	3.6E+04	1.0E-03	N/A	N/A	N/A	N/A	0.28	1.0E-05	1
Manganese	4.0E+02	1.0E-03	N/A	N/A	N/A	N/A	0.28	1.1E-07	1

Notes:

N/A - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm<sup>3</sup> (eq 1)

TABLE 7.8.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations							
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient			
							Value	Units	Value	Units		Value	Units	Value	Units				
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	5.9E-06	mg/kg-day	2.0E-03	mg/kg-day	2.9E-03			
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	1.1E-06	mg/kg-day	1.0E-04	mg/kg-day	1.1E-02			
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	7.7E-03	mg/kg-day	5.0E-04	mg/kg-day	1.5E+01			
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	1.0E-05	mg/kg-day	2.0E-03	mg/kg-day	5.2E-03			
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	1.4E-04	mg/kg-day	9.0E-04	mg/kg-day	1.6E-01			
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	1.4E-05	mg/kg-day	2.0E-03	mg/kg-day	6.9E-03			
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	3.2E-02	mg/kg-day	1.0E+00	mg/kg-day	3.2E-02			
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	1.8E-05	mg/kg-day	3.0E-04	mg/kg-day	5.9E-02			
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	2.8E-06	mg/kg-day	3.0E-03	mg/kg-day	9.4E-04			
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	7.9E-06	mg/kg-day	3.0E-04	mg/kg-day	2.6E-02			
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	4.6E-02	mg/kg-day	7.0E-01	mg/kg-day	6.6E-02			
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	3.4E-07	mg/kg-day	1.0E-05	mg/kg-day	3.4E-02			
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	7.2E-05	mg/kg-day	5.0E-03	mg/kg-day	1.4E-02			
				Exp. Route Total										N/A					1.6E+01
			Dermal Absorption <sup>1</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	N/A		N/A		N/A	1.4E-06	mg/kg-day	2.0E-03	mg/kg-day	6.9E-04			
				1,3-Dinitrobenzene	3.8E-01	mg/kg	N/A		N/A		N/A	2.6E-07	mg/kg-day	1.0E-04	mg/kg-day	2.6E-03			
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	N/A		N/A		N/A	5.7E-04	mg/kg-day	5.0E-04	mg/kg-day	1.1E+00			
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	N/A		N/A		N/A	1.4E-07	mg/kg-day	2.0E-03	mg/kg-day	7.2E-05			
				2-Nitrotoluene	4.8E+01	mg/kg	N/A		N/A		N/A	3.3E-05	mg/kg-day	9.0E-04	mg/kg-day	3.7E-02			
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	N/A		N/A		N/A	2.8E-07	mg/kg-day	2.0E-03	mg/kg-day	1.4E-04			
				Aluminum	1.1E+04	mg/kg	N/A		N/A		N/A	7.2E-04	mg/kg-day	1.0E+00	mg/kg-day	7.2E-04			
				Arsenic	5.9E+00	mg/kg	N/A		N/A		N/A	1.2E-06	mg/kg-day	3.0E-04	mg/kg-day	4.1E-03			
				Chromium (hexavalent)	9.4E-01	mg/kg	N/A		N/A		N/A	6.5E-08	mg/kg-day	7.5E-05	mg/kg-day	8.6E-04			
				Cobalt	2.6E+00	mg/kg	N/A		N/A		N/A	1.8E-07	mg/kg-day	3.0E-04	mg/kg-day	6.0E-04			
				Iron	1.5E+04	mg/kg	N/A		N/A		N/A	1.1E-03	mg/kg-day	7.0E-01	mg/kg-day	1.5E-03			
				Thallium	1.1E-01	mg/kg	N/A		N/A		N/A	7.8E-09	mg/kg-day	1.0E-05	mg/kg-day	7.8E-04			
				Vanadium	2.4E+01	mg/kg	N/A		N/A		N/A	1.6E-06	mg/kg-day	1.3E-04	mg/kg-day	1.3E-02			
				Exp. Route Total										N/A					1.2E+00
			Exposure Point Total											N/A					1.7E+01
			Exposure Medium Total											N/A					1.7E+01
Surface and Subsurface Soil Total											N/A					1.7E+01			

TABLE 7.8.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	6.4E-04	mg/kg-day	3.0E-04	mg/kg-day	2.1E+00
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	3.5E-05	mg/kg-day	3.0E-04	mg/kg-day	1.2E-01
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	3.1E-04	mg/kg-day	6.0E-04	mg/kg-day	5.2E-01
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	7.1E-01	mg/kg-day	7.0E-01	mg/kg-day	1.0E+00
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	7.9E-03	mg/kg-day	2.4E-02	mg/kg-day	3.3E-01
			Exp. Route Total							N/A					4.1E+00	
			Dermal	Arsenic	3.3E+01	ug/L	N/A		N/A		N/A	4.9E-06	mg/kg-day	3.0E-04	mg/kg-day	1.6E-02
				Cobalt	1.7E+00	ug/L	N/A		N/A		N/A	1.1E-07	mg/kg-day	3.0E-04	mg/kg-day	3.5E-04
				Cyanide	1.6E+01	ug/L	N/A		N/A		N/A	2.4E-06	mg/kg-day	6.0E-04	mg/kg-day	3.9E-03
				Iron	3.6E+04	ug/L	N/A		N/A		N/A	5.4E-03	mg/kg-day	7.0E-01	mg/kg-day	7.8E-03
				Manganese	4.0E+02	ug/L	N/A		N/A		N/A	6.0E-05	mg/kg-day	9.6E-04	mg/kg-day	6.3E-02
			Exp. Route Total							N/A					9.1E-02	
			Exposure Medium Total										N/A			
Groundwater Total										N/A					4.2E+00	
						Total of Receptor Risk				N/A	Total of Receptor Hazard				2.1E+01	

Notes-

DAevent for exposure to groundwater calculated on Table 7.8.CTE Supplement A.

<sup>1</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.

DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,

DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.

N/A = Not applicable.

Table 7.8.CTE Supplement A  
Calculation of DAevent for Groundwater  
Child Resident  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical of Potential Concern	Water Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (t <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	3.3E+01	1.0E-03	N/A	N/A	N/A	N/A	0.37	1.2E-08	1
Cobalt	1.7E+00	4.0E-04	N/A	N/A	N/A	N/A	0.37	2.6E-10	1
Cyanide	1.6E+01	1.0E-03	N/A	N/A	N/A	N/A	0.37	5.8E-09	1
Iron	3.6E+04	1.0E-03	N/A	N/A	N/A	N/A	0.37	1.3E-05	1
Manganese	4.0E+02	1.0E-03	N/A	N/A	N/A	N/A	0.37	1.5E-07	1

Notes:

N/A - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm<sup>3</sup> (eq 1)

TABLE 7.9.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations								
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient				
							Value	Units	Value	Units		Value	Units	Value	Units					
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	2,4-Dinitrotoluene	2.0E+00	mg/kg	5.6E-07	mg/kg-day	3.1E-01	mg/kg-day	1.7E-07	N/A		N/A		N/A				
				1,3-Dinitrobenzene	3.8E-01	mg/kg	1.1E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2,4,6-Trinitrotoluene	2.6E+03	mg/kg	7.4E-04	mg/kg-day	3.0E-02	mg/kg-day	2.2E-05	N/A		N/A		N/A				
				2-Amino-4,6-dinitrotoluene	3.5E+00	mg/kg	1.0E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				2-Nitrotoluene	4.8E+01	mg/kg	1.4E-05	mg/kg-day	2.2E-01	mg/kg-day	3.0E-06	N/A		N/A		N/A				
				4-Amino-2,6-dinitrotoluene	4.6E+00	mg/kg	1.3E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Aluminum	1.1E+04	mg/kg	3.0E-03	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Arsenic	5.9E+00	mg/kg	1.7E-06	mg/kg-day	1.5E+00	mg/kg-day	2.5E-06	N/A		N/A		N/A				
				Chromium (hexavalent) <sup>1</sup>	9.4E-01	mg/kg	2.7E-07	mg/kg-day	5.0E-01	mg/kg-day	7.0E-07	N/A		N/A		N/A				
				Cobalt	2.6E+00	mg/kg	7.6E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Iron	1.5E+04	mg/kg	4.4E-03	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Thallium	1.1E-01	mg/kg	3.3E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Vanadium	2.4E+01	mg/kg	6.8E-06	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
				Exp. Route Total											2.9E-05					N/A
				Dermal Absorption <sup>2</sup>	2,4-Dinitrotoluene	2.0E+00	mg/kg	1.4E-07	mg/kg-day	3.1E-01	mg/kg-day	4.2E-08	N/A		N/A		N/A			
			1,3-Dinitrobenzene		3.8E-01	mg/kg	2.6E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			2,4,6-Trinitrotoluene		2.6E+03	mg/kg	5.6E-05	mg/kg-day	3.0E-02	mg/kg-day	1.7E-06	N/A		N/A		N/A				
			2-Amino-4,6-dinitrotoluene		3.5E+00	mg/kg	1.4E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			2-Nitrotoluene		4.8E+01	mg/kg	3.3E-06	mg/kg-day	2.2E-01	mg/kg-day	7.2E-07	N/A		N/A		N/A				
			4-Amino-2,6-dinitrotoluene		4.6E+00	mg/kg	2.8E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Aluminum		1.1E+04	mg/kg	7.2E-05	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Arsenic		5.9E+00	mg/kg	1.2E-07	mg/kg-day	1.5E+00	mg/kg-day	1.8E-07	N/A		N/A		N/A				
			Chromium (hexavalent) <sup>1</sup>		9.4E-01	mg/kg	6.4E-09	mg/kg-day	2.0E+01	mg/kg-day	6.4E-07	N/A		N/A		N/A				
			Cobalt		2.6E+00	mg/kg	1.8E-08	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Iron		1.5E+04	mg/kg	1.1E-04	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Thallium		1.1E-01	mg/kg	7.8E-10	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Vanadium		2.4E+01	mg/kg	1.6E-07	mg/kg-day	N/A		N/A	N/A		N/A		N/A				
			Exp. Route Total												3.3E-06					N/A
			Exposure Point Total												3.2E-05					N/A
															3.2E-05					N/A
Exposure Medium Total												3.2E-05					N/A			
Surface and Subsurface Soil Total												3.2E-05					N/A			

TABLE 7.9.CTE  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	3.3E+01	ug/L	1.1E-04	mg/kg-day	1.5E+00	1/mg/kg-day	1.6E-04	N/A		N/A		N/A	
				Cobalt	1.7E+00	ug/L	5.7E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Cyanide	1.6E+01	ug/L	5.1E-05	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Iron	3.6E+04	ug/L	1.2E-01	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Manganese	4.0E+02	ug/L	1.3E-03	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
			Exp. Route Total									1.6E-04					N/A
			Dermal	Arsenic	3.3E+01	ug/L	7.1E-07	mg/kg-day	1.5E+00	1/mg/kg-day	1.1E-06	N/A		N/A		N/A	
				Cobalt	1.7E+00	ug/L	1.5E-08	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Cyanide	1.6E+01	ug/L	3.4E-07	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Iron	3.6E+04	ug/L	7.9E-04	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
				Manganese	4.0E+02	ug/L	8.8E-06	mg/kg-day	N/A	1/mg/kg-day	N/A	N/A		N/A		N/A	
			Exp. Route Total									1.1E-06					N/A
Exposure Medium Total										1.6E-04					N/A		
Groundwater Total										1.6E-04					N/A		
						Total of Receptor Risk				1.9E-04	Total of Receptor Hazard				N/A		

Notes-

- <sup>1</sup> See Table 7.9.CTE Supplement A for calculation of intake and cancer risk following MMOA method.
- <sup>2</sup> Dermal absorption factors (DABS) used to calculate dermal absorption intake from soil are chemical specific.
- DABS of 0.102 used for 2,4-dinitrotoluene, DABS of 0.032 used for 2,4,6-trinitrotoluene, DABS of 0.006 used for 2-Amino-4,6-dinitrotoluene, DABS of 0.009 used for 4-Amino-2,6-dinitrotoluene, DABS of 0.1 used for all other explosives,
- DABS of 0.03 used for arsenic, and DABS of 0.01 for all other inorganics.
- DAevent for exposure to groundwater calculated on Tables 7.7.CTE Supplement A and 7.8.CTE Supplement A.

TABLE 7.9.CTE Supplement A  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
					Value	Units	Intake				CSF/Unit Risk					Cancer Risk	
							Value				Units	Value					Units
							0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)		
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	Ingestion	Chromium (hexavalent)	9.4E-01	mg/kg	8.1E-08	1.6E-07	3.3E-08		mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	7.0E-07
			Dermal	Chromium (hexavalent)	9.4E-01	mg/kg	1.8E-09	3.7E-09	8.7E-10		mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	6.4E-07

Cancer risk = (Intake<sub>0-2</sub> x CSF<sub>0-2</sub>) + (Intake<sub>2-6</sub> x CSF<sub>2-6</sub>) + (Intake<sub>6-16</sub> x CSF<sub>6-16</sub>) + (Intake<sub>16-26</sub> x CSF<sub>16-26</sub>)

Notes:  
ADAF = Age-dependent adjustment factor  
CSF = Cancer slope factor  
EPC = Exposure point concentration  
mg/kg = milligram per kilogram  
mg/kg-day = milligram per kilogram per day

TABLE 9.1.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	1E-07	N/A	4E-08	1E-07	Neurological, Blood, Biliary Tract	4E-04	N/A	2E-04	6E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	4E-03	N/A	2E-03	5E-03
			2,4,6-Trinitrotoluene	5E-05	N/A	7E-06	6E-05	Liver	1E+01	N/A	1E+00	1E+01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-03	N/A	4E-05	2E-03
			2-Nitrotoluene	3E-06	N/A	1E-06	4E-06	Bone Marrow	4E-02	N/A	2E-02	6E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-03	N/A	7E-05	2E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	8E-03	N/A	3E-04	8E-03
			Arsenic	2E-06	N/A	3E-07	2E-06	Skin, Vascular	1E-02	N/A	2E-03	1E-02
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	6E-03	N/A	3E-04	6E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	2E-02	N/A	7E-04	2E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	8E-03	N/A	3E-04	9E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	3E-03	N/A	6E-03	9E-03
			Chemical Total	6E-05	N/A	9E-06	7E-05		1E+01	N/A	1E+00	1E+01
	Exposure Point Total						7E-05				1E+01	
Exposure Medium Total						7E-05				1E+01		
Surface Soil Total						7E-05				1E+01		
Receptor Total						7E-05	Receptor HI Total			1E+01		

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	5E-03
Total Liver HI Across All Media =	1E+01
Total Neurological HI Across All Media =	1E-02
Total Skin HI Across All Media =	1E-02
Total Vascular HI Across All Media =	1E-02
Total Thyroid HI Across All Media =	6E-03
Total Gastrointestinal HI Across All Media =	2E-02
Total Hair HI Across All Media =	9E-03
Total Blood HI Across All Media =	4E-03
Total Biliary Tract HI Across All Media =	4E-03
Total Bone Marrow HI Across All Media =	6E-02
Total Kidney HI Across All Media =	9E-03

TABLE 9.2.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	2E-08	N/A	8E-09	3E-08	Neurological, Blood, Biliary Tract	1E-04	N/A	4E-05	1E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	Spleen	9E-04	N/A	4E-04	1E-03	
			2,4,6-Trinitrotoluene	1E-05	N/A	1E-06	1E-05	Liver	2E+00	N/A	3E-01	3E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-04	N/A	9E-06	4E-04
			2-Nitrotoluene	5E-07	N/A	2E-07	8E-07	Bone Marrow	9E-03	N/A	4E-03	1E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-04	N/A	2E-05	5E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-03	N/A	7E-05	2E-03
			Arsenic	4E-07	N/A	5E-08	4E-07	Skin, Vascular	3E-03	N/A	4E-04	3E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-03	N/A	6E-05	1E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	4E-03	N/A	2E-04	4E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-03	N/A	8E-05	2E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	8E-04	N/A	1E-03	2E-03
			Chemical Total	1E-05	N/A	2E-06	1E-05		2E+00	N/A	3E-01	3E+00
		Exposure Point Total							1E-05			
Exposure Medium Total							1E-05					3E+00
Surface Soil Total							1E-05					3E+00
Receptor Total							1E-05	Receptor HI Total				3E+00

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	1E-03
Total Liver HI Across All Media =	3E+00
Total Neurological HI Across All Media =	3E-03
Total Skin HI Across All Media =	3E-03
Total Vascular HI Across All Media =	3E-03
Total Thyroid HI Across All Media =	1E-03
Total Gastrointestinal HI Across All Media =	4E-03
Total Hair HI Across All Media =	2E-03
Total Blood HI Across All Media =	1E-03
Total Biliary Tract HI Across All Media =	1E-03
Total Bone Marrow HI Across All Media =	1E-02
Total Kidney HI Across All Media =	2E-03

TABLE 9.3.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	6E-08	N/A	2E-08	7E-08	Neurological, Blood, Biliary Tract	1E-03	N/A	3E-04	1E-03
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	9E-03	N/A	2E-03	1E-02
			2,4,6-Trinitrotoluene	3E-05	N/A	3E-06	3E-05	Liver	2E+01	N/A	2E+00	3E+01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-03	N/A	6E-05	4E-03
			2-Nitrotoluene	2E-06	N/A	5E-07	2E-06	Bone Marrow	1E-01	N/A	3E-02	1E-01
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	5E-03	N/A	1E-04	5E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-02	N/A	5E-04	2E-02
			Arsenic	1E-06	N/A	1E-07	1E-06	Skin, Vascular	3E-02	N/A	3E-03	3E-02
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-02	N/A	4E-04	2E-02
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	4E-02	N/A	1E-03	4E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-02	N/A	6E-04	2E-02
			Vanadium	N/A	N/A	N/A	N/A	Kidney	9E-03	N/A	9E-03	2E-02
			Chemical Total	4E-05	N/A	3E-06	4E-05		3E+01	N/A	2E+00	3E+01
	Exposure Point Total				4E-05				3E+01			
Exposure Medium Total				4E-05				3E+01				
Surface Soil Total						4E-05				3E+01		
Receptor Total						4E-05	Receptor HI Total			3E+01		

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	1E-02
Total Liver HI Across All Media =	3E+01
Total Neurological HI Across All Media =	3E-02
Total Skin HI Across All Media =	3E-02
Total Vascular HI Across All Media =	3E-02
Total Thyroid HI Across All Media =	2E-02
Total Gastrointestinal HI Across All Media =	4E-02
Total Hair HI Across All Media =	2E-02
Total Blood HI Across All Media =	1E-02
Total Biliary Tract HI Across All Media =	1E-02
Total Bone Marrow HI Across All Media =	1E-01
Total Kidney HI Across All Media =	2E-02

TABLE 9.4.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	2E-07	N/A	7E-08	2E-07	Neurological, Blood, Biliary Tract	8E-04	N/A	3E-04	1E-03
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	3E-03	N/A	1E-03	4E-03
			2,4,6-Trinitrotoluene	2E-05	N/A	3E-06	2E-05	Liver	4E+00	N/A	5E-01	4E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	1E-03	N/A	3E-05	1E-03
			2-Nitrotoluene	3E-06	N/A	1E-06	4E-06	Bone Marrow	4E-02	N/A	2E-02	6E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-03	N/A	7E-05	2E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	8E-03	N/A	3E-04	8E-03
			Arsenic	2E-06	N/A	3E-07	3E-06	Skin, Vascular	2E-02	N/A	2E-03	2E-02
			Chromium (hexavalent)	1E-07	N/A	2E-07	3E-07	NOE	2E-04	N/A	4E-04	6E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	7E-03	N/A	3E-04	7E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	2E-02	N/A	7E-04	2E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	9E-03	N/A	4E-04	9E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	4E-03	N/A	6E-03	1E-02
			Chemical Total	3E-05	N/A	5E-06	3E-05		4E+00	N/A	6E-01	5E+00
	Exposure Point Total						3E-05				5E+00	
Exposure Medium Total						3E-05				5E+00		
Surface and Subsurface Soil Total						3E-05				5E+00		
Groundwater	Groundwater	Tap Water	Arsenic	2E-04	N/A	N/A	2E-04	Skin, Vascular	1E+00	N/A	N/A	1E+00
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	6E-02	N/A	N/A	6E-02
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	3E-01	N/A	N/A	3E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	6E-01	N/A	N/A	6E-01
			Manganese	N/A	N/A	N/A	N/A	Neurological	2E-01	N/A	N/A	2E-01
	Chemical Total	2E-04	N/A	N/A	2E-04		2E+00	N/A	N/A	2E+00		
Exposure Point Total						2E-04				2E+00		
Exposure Medium Total						2E-04				2E+00		
Groundwater Total						2E-04				2E+00		
Receptor Total						2E-04	Receptor HI Total			7E+00		

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	2E-01
Total Blood HI Across All Media =	4E-03
Total Biliary Tract HI Across All Media =	4E-03
Total Spleen HI Across All Media =	4E-03
Total Liver HI Across All Media =	4E+00
Total Skin HI Across All Media =	1E+00
Total Vascular HI Across All Media =	1E+00
Total Thyroid HI Across All Media =	7E-02
Total Gastrointestinal HI Across All Media =	6E-01
Total Hair HI Across All Media =	9E-03
Total Reproductive HI Across All Media =	3E-01
Total Bone Marrow HI Across All Media =	6E-02
Total Kidney HI Across All Media =	1E-02

TABLE 9.5.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	3E-08	N/A	1E-08	4E-08	Neurological, Blood, Biliary Tract	2E-04	N/A	8E-05	2E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	7E-04	N/A	3E-04	1E-03
			2,4,6-Trinitrotoluene	4E-06	N/A	5E-07	4E-06	Liver	9E-01	N/A	1E-01	1E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-04	N/A	8E-06	3E-04
			2-Nitrotoluene	5E-07	N/A	2E-07	8E-07	Bone Marrow	9E-03	N/A	4E-03	1E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-04	N/A	2E-05	4E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-03	N/A	8E-05	2E-03
			Arsenic	4E-07	N/A	6E-08	5E-07	Skin, Vascular	3E-03	N/A	4E-04	4E-03
			Chromium (hexavalent)	2E-08	N/A	4E-08	6E-08	NOE	6E-05	N/A	9E-05	2E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-03	N/A	7E-05	2E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	4E-03	N/A	2E-04	4E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-03	N/A	9E-05	2E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	8E-04	N/A	1E-03	2E-03
			Chemical Total	5E-06	N/A	9E-07	6E-06		9E-01	N/A	1E-01	1E+00
Exposure Point Total							6E-06					1E+00
Exposure Medium Total							6E-06					1E+00
Surface and Subsurface Soil Total							6E-06					1E+00
Receptor Total							6E-06	Receptor HI Total				1E+00

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Neurological HI Across All Media =	3E-03
Total Blood HI Across All Media =	1E-03
Total Billiary Tract HI Across All Media =	1E-03
Total Spleen HI Across All Media =	1E-03
Total Liver HI Across All Media =	1E+00
Total Skin HI Across All Media =	4E-03
Total Vascular HI Across All Media =	4E-03
Total Thyroid HI Across All Media =	2E-03
Total Gastrointestinal HI Across All Media =	4E-03
Total Hair HI Across All Media =	2E-03
Total Bone Marrow HI Across All Media =	1E-02
Total Kidney HI Across All Media =	2E-03

TABLE 9.6.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	1E-07	N/A	3E-08	1E-07	Neurological, Blood, Biliary Tract	2E-03	N/A	5E-04	2E-03
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	7E-03	N/A	2E-03	9E-03
			2,4,6-Trinitrotoluene	1E-05	N/A	1E-06	1E-05	Liver	1E+01	N/A	8E-01	1E+01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-03	N/A	5E-05	3E-03
			2-Nitrotoluene	2E-06	N/A	5E-07	2E-06	Bone Marrow	1E-01	N/A	3E-02	1E-01
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-03	N/A	1E-04	4E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-02	N/A	5E-04	2E-02
			Arsenic	1E-06	N/A	1E-07	2E-06	Skin, Vascular	4E-02	N/A	3E-03	4E-02
			Chromium (hexavalent)	4E-07	N/A	4E-07	8E-07	NOE	6E-04	N/A	6E-04	1E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-02	N/A	4E-04	2E-02
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	4E-02	N/A	1E-03	4E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-02	N/A	6E-04	2E-02
			Vanadium	N/A	N/A	N/A	N/A	Kidney	9E-03	N/A	9E-03	2E-02
			Chemical Total	2E-05	N/A	2E-06	2E-05		1E+01	N/A	9E-01	1E+01
	Exposure Point Total							2E-05				
Exposure Medium Total							2E-05					1E+01
Surface and Subsurface Soil Total							2E-05					1E+01
Receptor Total							2E-05	Receptor HI Total				1E+01

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Neurological HI Across All Media =	3E-02
Total Blood HI Across All Media =	1E-02
Total Billiary Tract HI Across All Media =	1E-02
Total Spleen HI Across All Media =	9E-03
Total Liver HI Across All Media =	1E+01
Total Skin HI Across All Media =	4E-02
Total Vascular HI Across All Media =	4E-02
Total Thyroid HI Across All Media =	2E-02
Total Gastrointestinal HI Across All Media =	4E-02
Total Hair HI Across All Media =	2E-02
Total Bone Marrow HI Across All Media =	1E-01
Total Kidney HI Across All Media =	2E-02

TABLE 9.7.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	1E-08	N/A	4E-09	2E-08	Blood	4E-04	N/A	1E-04	5E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Blood	1E-03	N/A	3E-04	1E-03
			2,4,6-Trinitrotoluene	2E-06	N/A	2E-07	2E-06	Liver	7E+00	N/A	7E-01	8E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-03	N/A	5E-05	2E-03
			2-Nitrotoluene	2E-07	N/A	7E-08	3E-07	Spleen, Blood	7E-03	N/A	2E-03	9E-03
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-03	N/A	9E-05	3E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	1E-02	N/A	5E-04	2E-02
			Arsenic	2E-07	N/A	2E-08	2E-07	Skin	3E-02	N/A	3E-03	3E-02
			Chromium (hexavalent)	9E-09	N/A	1E-08	2E-08	Blood	3E-04	N/A	3E-04	6E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-03	N/A	4E-05	1E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	3E-02	N/A	1E-03	3E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	4E-03	N/A	1E-04	4E-03
			Vanadium	N/A	N/A	N/A	N/A	Blood	3E-03	N/A	4E-03	7E-03
			Chemical Total	2E-06	N/A	3E-07	2E-06		7E+00	N/A	7E-01	8E+00
		Exposure Point Total							2E-06			
Exposure Medium Total							2E-06					8E+00
Surface and Subsurface Soil Total							2E-06					8E+00
Groundwater	Groundwater	Water in Excavation Trench	Arsenic	N/A	N/A	1E-07	1E-07	Skin	N/A	N/A	2E-02	2E-02
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	N/A	N/A	5E-05	5E-05
			Cyanide	N/A	N/A	N/A	N/A	Whole Body, Thyroid, Neurological	N/A	N/A	2E-04	2E-04
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	N/A	N/A	1E-02	1E-02
			Manganese	N/A	N/A	N/A	N/A	Neurological	N/A	N/A	9E-02	9E-02
			Chemical Total	N/A	N/A	1E-07	1E-07		N/A	N/A	1E-01	1E-01
		Exposure Point Total							1E-07			
Exposure Medium Total							1E-07					1E-01
Groundwater Total							1E-07					1E-01
Receptor Total							2E-06	Receptor HI Total				8E+00

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Blood HI Across All Media =	2E-02
Total Liver HI Across All Media =	8E+00
Total Neurological HI Across All Media =	1E-01
Total Skin HI Across All Media =	5E-02
Total Thyroid HI Across All Media =	1E-03
Total Gastrointestinal HI Across All Media =	4E-02
Total Hair HI Across All Media =	4E-03
Total Whole Body HI Across All Media =	2E-04
Total Biliary Tract HI Across All Media =	6E-03
Total Spleen HI Across All Media =	9E-03

TABLE 9.8.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	1E-03	N/A	5E-04	2E-03
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	5E-03	N/A	2E-03	6E-03
			2,4,6-Trinitrotoluene	N/A	N/A	N/A	N/A	Liver	6E+00	N/A	8E-01	7E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-03	N/A	5E-05	2E-03
			2-Nitrotoluene	N/A	N/A	N/A	N/A	Bone Marrow	6E-02	N/A	3E-02	9E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-03	N/A	1E-04	3E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	1E-02	N/A	5E-04	1E-02
			Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	2E-02	N/A	3E-03	3E-02
			Chromium (hexavalent)	N/A	N/A	N/A	N/A	NOE	4E-04	N/A	6E-04	1E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-02	N/A	4E-04	1E-02
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	3E-02	N/A	1E-03	3E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	1E-02	N/A	6E-04	1E-02
			Vanadium	N/A	N/A	N/A	N/A	Kidney	6E-03	N/A	9E-03	1E-02
			Chemical Total	N/A	N/A	N/A	N/A		6E+00	N/A	9E-01	7E+00
	Exposure Point Total						N/A					7E+00
Exposure Medium Total						N/A					7E+00	
Surface and Subsurface Soil Total						N/A					7E+00	
Groundwater	Groundwater	Tap Water	Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	3E+00	N/A	2E-02	3E+00
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-01	N/A	4E-04	2E-01
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	8E-01	N/A	5E-03	8E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	2E+00	N/A	9E-03	2E+00
			Manganese	N/A	N/A	N/A	N/A	Neurological	5E-01	N/A	7E-02	6E-01
	Chemical Total	N/A	N/A	N/A	N/A		6E+00	N/A	1E-01	6E+00		
Exposure Point Total						N/A					6E+00	
Exposure Medium Total						N/A					6E+00	
Groundwater Total						N/A					6E+00	
Receptor Total						N/A	Receptor HI Total				1E+01	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	6E-01
Total Blood HI Across All Media =	7E-03
Total Billiary Tract HI Across All Media =	7E-03
Total Spleen HI Across All Media =	6E-03
Total Liver HI Across All Media =	7E+00
Total Skin HI Across All Media =	3E+00
Total Vascular HI Across All Media =	3E+00
Total Thyroid HI Across All Media =	2E-01
Total Gastrointestinal HI Across All Media =	2E+00
Total Hair HI Across All Media =	1E-02
Total Reproductive HI Across All Media =	8E-01
Total Bone Marrow HI Across All Media =	9E-02
Total Kidney HI Across All Media =	1E-02

TABLE 9.9.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	1E-02	N/A	3E-03	2E-02
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	5E-02	N/A	1E-02	6E-02
			2,4,6-Trinitrotoluene	N/A	N/A	N/A	N/A	Liver	7E+01	N/A	6E+00	7E+01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-02	N/A	4E-04	2E-02
			2-Nitrotoluene	N/A	N/A	N/A	N/A	Bone Marrow	7E-01	N/A	2E-01	9E-01
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-02	N/A	7E-04	3E-02
			Aluminum	N/A	N/A	N/A	N/A	Neurological	1E-01	N/A	4E-03	1E-01
			Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	3E-01	N/A	2E-02	3E-01
			Chromium (hexavalent)	N/A	N/A	N/A	N/A	NOE	4E-03	N/A	4E-03	8E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-01	N/A	3E-03	1E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	3E-01	N/A	8E-03	3E-01
			Thallium	N/A	N/A	N/A	N/A	Hair	1E-01	N/A	4E-03	1E-01
			Vanadium	N/A	N/A	N/A	N/A	Kidney	6E-02	N/A	6E-02	1E-01
			Chemical Total	N/A	N/A	N/A	N/A		7E+01	N/A	6E+00	7E+01
	Exposure Point Total										7E+01	
Exposure Medium Total											7E+01	
Surface and Subsurface Soil Total											7E+01	
Groundwater	Groundwater	Tap Water	Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	5E+00	N/A	2E-02	5E+00
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	3E-01	N/A	5E-04	3E-01
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	1E+00	N/A	6E-03	1E+00
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	3E+00	N/A	1E-02	3E+00
			Manganese	N/A	N/A	N/A	N/A	Neurological	8E-01	N/A	9E-02	9E-01
	Chemical Total	N/A	N/A	N/A	N/A		1E+01	N/A	1E-01	1E+01		
Exposure Point Total										1E+01		
Exposure Medium Total											1E+01	
Groundwater Total											1E+01	
Receptor Total							Receptor HI Total				8E+01	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	1E+00
Total Blood HI Across All Media =	7E-02
Total Billiary Tract HI Across All Media =	7E-02
Total Spleen HI Across All Media =	6E-02
Total Liver HI Across All Media =	7E+01
Total Skin HI Across All Media =	6E+00
Total Vascular HI Across All Media =	6E+00
Total Thyroid HI Across All Media =	4E-01
Total Gastrointestinal HI Across All Media =	3E+00
Total Hair HI Across All Media =	1E-01
Total Reproductive HI Across All Media =	1E+00
Total Bone Marrow HI Across All Media =	9E-01
Total Kidney HI Across All Media =	1E-01

TABLE 9.10.RME  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future

Receptor Population: Resident

Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	9E-07	N/A	3E-07	1E-06		N/A	N/A	N/A	N/A
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			2,4,6-Trinitrotoluene	1E-04	N/A	1E-05	1E-04		N/A	N/A	N/A	N/A
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			2-Nitrotoluene	2E-05	N/A	5E-06	2E-05		N/A	N/A	N/A	N/A
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Aluminum	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Arsenic	1E-05	N/A	1E-06	1E-05		N/A	N/A	N/A	N/A
			Chromium (hexavalent)	3E-06	N/A	3E-06	7E-06		N/A	N/A	N/A	N/A
			Cobalt	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Iron	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Thallium	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Vanadium	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
		Chemical Total	1E-04	N/A	2E-05	2E-04		N/A	N/A	N/A	N/A	
		Exposure Point Total				2E-04				N/A		
	Exposure Medium Total					2E-04				N/A		
Surface and Subsurface Soil Total						2E-04				N/A		
Groundwater	Groundwater	Tap Water	Arsenic	6E-04	N/A	3E-06	6E-04		N/A	N/A	N/A	N/A
			Cobalt	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Cyanide	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Iron	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Manganese	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
		Chemical Total	6E-04	N/A	3E-06	6E-04		N/A	N/A	N/A	N/A	
		Exposure Point Total				6E-04				N/A		
	Exposure Medium Total					6E-04				N/A		
Groundwater Total						6E-04				N/A		
Receptor Total						8E-04	Receptor HI Total			N/A		

Notes:  
N/A = Not applicable  
HI = Hazard Index

TABLE 9.1.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	2E-08	N/A	2E-09	2E-08	Neurological, Blood, Biliary Tract	2E-04	N/A	3E-05	2E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	Spleen	2E-03	N/A	3E-04	2E-03	
			2,4,6-Trinitrotoluene	9E-06	N/A	4E-07	1E-05	Liver	5E+00	N/A	2E-01	5E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	8E-04	N/A	6E-06	8E-04	
			2-Nitrotoluene	5E-07	N/A	7E-08	6E-07	Bone Marrow	2E-02	N/A	3E-03	2E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	9E-04	N/A	1E-05	1E-03	
			Aluminum	N/A	N/A	N/A	Neurological	4E-03	N/A	5E-05	4E-03	
			Arsenic	4E-07	N/A	1E-08	4E-07	Skin, Vascular	6E-03	N/A	3E-04	6E-03
			Cobalt	N/A	N/A	N/A	Thyroid	3E-03	N/A	4E-05	3E-03	
			Iron	N/A	N/A	N/A	Gastrointestinal	8E-03	N/A	1E-04	9E-03	
			Thallium	N/A	N/A	N/A	Hair	4E-03	N/A	6E-05	4E-03	
			Vanadium	N/A	N/A	N/A	Kidney	2E-03	N/A	9E-04	3E-03	
			Chemical Total	1E-05	N/A	5E-07	1E-05		5E+00	N/A	2E-01	5E+00
		Exposure Point Total				1E-05				5E+00		
Exposure Medium Total				1E-05				5E+00				
Surface Soil Total							1E-05				5E+00	
Receptor Total							1E-05	Receptor HI Total			5E+00	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	2E-03
Total Liver HI Across All Media =	5E+00
Total Neurological HI Across All Media =	6E-03
Total Skin HI Across All Media =	6E-03
Total Vascular HI Across All Media =	6E-03
Total Thyroid HI Across All Media =	3E-03
Total Gastrointestinal HI Across All Media =	9E-03
Total Hair HI Across All Media =	4E-03
Total Blood HI Across All Media =	2E-03
Total Biliary Tract HI Across All Media =	2E-03
Total Bone Marrow HI Across All Media =	2E-02
Total Kidney HI Across All Media =	3E-03

TABLE 9.2.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	8E-10	N/A	2E-10	1E-09	Neurological, Blood, Billiary Tract	1E-05	N/A	3E-06	1E-05
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	9E-05	N/A	3E-05	1E-04
			2,4,6-Trinitrotoluene	5E-07	N/A	4E-08	5E-07	Liver	2E-01	N/A	2E-02	3E-01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Billiary Tract	4E-05	N/A	7E-07	4E-05
			2-Nitrotoluene	2E-08	N/A	7E-09	3E-08	Bone Marrow	9E-04	N/A	3E-04	1E-03
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Billiary Tract	4E-05	N/A	1E-06	5E-05
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-04	N/A	5E-06	2E-04
			Arsenic	2E-08	N/A	2E-09	2E-08	Skin, Vascular	3E-04	N/A	3E-05	3E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-04	N/A	4E-06	1E-04
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	4E-04	N/A	1E-05	4E-04
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-04	N/A	6E-06	2E-04
			Vanadium	N/A	N/A	N/A	N/A	Kidney	8E-05	N/A	9E-05	2E-04
			Chemical Total	5E-07	N/A	5E-08	5E-07		2E-01	N/A	2E-02	3E-01
			Exposure Point Total				5E-07					3E-01
			Exposure Medium Total				5E-07					3E-01
			Surface Soil Total				5E-07					3E-01
			Receptor Total				5E-07					3E-01

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	1E-04
Total Liver HI Across All Media =	3E-01
Total Neurological HI Across All Media =	3E-04
Total Skin HI Across All Media =	3E-04
Total Vascular HI Across All Media =	3E-04
Total Thyroid HI Across All Media =	1E-04
Total Gastrointestinal HI Across All Media =	4E-04
Total Hair HI Across All Media =	2E-04
Total Blood HI Across All Media =	1E-04
Total Biliary Tract HI Across All Media =	1E-04
Total Bone Marrow HI Across All Media =	1E-03
Total Kidney HI Across All Media =	2E-04

TABLE 9.3.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4-Dinitrotoluene	7E-09	N/A	2E-09	8E-09	Neurological, Blood, Billiary Tract	1E-04	N/A	3E-05	2E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	1E-03	N/A	2E-04	1E-03
			2,4,6-Trinitrotoluene	4E-06	N/A	3E-07	4E-06	Liver	3E+00	N/A	2E-01	3E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Billiary Tract	5E-04	N/A	6E-06	5E-04
			2-Nitrotoluene	2E-07	N/A	5E-08	2E-07	Bone Marrow	1E-02	N/A	3E-03	1E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Billiary Tract	6E-04	N/A	1E-05	6E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-03	N/A	5E-05	2E-03
			Arsenic	1E-07	N/A	1E-08	2E-07	Skin, Vascular	4E-03	N/A	3E-04	4E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-03	N/A	4E-05	2E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	5E-03	N/A	1E-04	5E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	2E-03	N/A	6E-05	2E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	1E-03	N/A	9E-04	2E-03
			Chemical Total	4E-06	N/A	3E-07	4E-06		3E+00	N/A	2E-01	3E+00
			Exposure Point Total				4E-06					3E+00
			Exposure Medium Total				4E-06					3E+00
			Surface Soil Total				4E-06					3E+00
			Receptor Total				4E-06				Receptor HI Total	3E+00

Notes:

N/A = Not applicable

HI = Hazard Index

Total Spleen HI Across All Media =	1E-03
Total Liver HI Across All Media =	3E+00
Total Neurological HI Across All Media =	3E-03
Total Skin HI Across All Media =	4E-03
Total Vascular HI Across All Media =	4E-03
Total Thyroid HI Across All Media =	2E-03
Total Gastrointestinal HI Across All Media =	5E-03
Total Hair HI Across All Media =	2E-03
Total Blood HI Across All Media =	1E-03
Total Biliary Tract HI Across All Media =	1E-03
Total Bone Marrow HI Across All Media =	1E-02
Total Kidney HI Across All Media =	2E-03

TABLE 9.4.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	3E-08	N/A	4E-09	3E-08	Neurological, Blood, Biliary Tract	4E-04	N/A	5E-05	4E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	Spleen	1E-03	N/A	2E-04	2E-03	
			2,4,6-Trinitrotoluene	4E-06	N/A	2E-07	4E-06	Liver	2E+00	N/A	9E-02	2E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	7E-04	N/A	5E-06	7E-04
			2-Nitrotoluene	5E-07	N/A	7E-08	6E-07	Bone Marrow	2E-02	N/A	3E-03	2E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	9E-04	N/A	1E-05	9E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	4E-03	N/A	5E-05	4E-03
			Arsenic	4E-07	N/A	2E-08	4E-07	Skin, Vascular	7E-03	N/A	3E-04	8E-03
			Chromium (hexavalent)	2E-08	N/A	1E-08	4E-08	NOE	1E-04	N/A	7E-05	2E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	3E-03	N/A	5E-05	3E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	8E-03	N/A	1E-04	8E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	4E-03	N/A	6E-05	4E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	2E-03	N/A	1E-03	3E-03
			Chemical Total	5E-06	N/A	3E-07	5E-06		2E+00	N/A	9E-02	2E+00
		Exposure Point Total							5E-06			
Exposure Medium Total							5E-06					2E+00
Surface and Subsurface Soil Total						5E-06					2E+00	
Groundwater	Groundwater	Tap Water	Arsenic	2E-05	N/A	N/A	2E-05	Skin, Vascular	4E-01	N/A	N/A	4E-01
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-02	N/A	N/A	2E-02
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	1E-01	N/A	N/A	1E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	2E-01	N/A	N/A	2E-01
			Manganese	N/A	N/A	N/A	N/A	Neurological	6E-02	N/A	N/A	6E-02
Chemical Total			2E-05	N/A	N/A	2E-05		8E-01	N/A	N/A	8E-01	
Exposure Point Total							2E-05					8E-01
Exposure Medium Total							2E-05					8E-01
Groundwater Total						2E-05					8E-01	
Receptor Total						3E-05	Receptor HI Total				3E+00	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	7E-02
Total Blood HI Across All Media =	2E-03
Total Biliary Tract HI Across All Media =	2E-03
Total Spleen HI Across All Media =	2E-03
Total Liver HI Across All Media =	2E+00
Total Skin HI Across All Media =	4E-01
Total Vascular HI Across All Media =	4E-01
Total Thyroid HI Across All Media =	3E-02
Total Gastrointestinal HI Across All Media =	2E-01
Total Hair HI Across All Media =	4E-03
Total Reproductive HI Across All Media =	1E-01
Total Bone Marrow HI Across All Media =	2E-02
Total Kidney HI Across All Media =	3E-03

TABLE 9.5.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	1E-08	N/A	3E-09	1E-08	Neurological, Blood, Biliary Tract	2E-04	N/A	5E-05	3E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	8E-04	N/A	2E-04	1E-03
			2,4,6-Trinitrotoluene	1E-06	N/A	1E-07	2E-06	Liver	1E+00	N/A	8E-02	1E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-04	N/A	5E-06	4E-04
			2-Nitrotoluene	2E-07	N/A	5E-08	2E-07	Bone Marrow	1E-02	N/A	3E-03	1E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	5E-04	N/A	1E-05	5E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	2E-03	N/A	5E-05	2E-03
			Arsenic	2E-07	N/A	1E-08	2E-07	Skin, Vascular	4E-03	N/A	3E-04	5E-03
			Chromium (hexavalent)	5E-08	N/A	4E-08	9E-08	NOE	7E-05	N/A	6E-05	1E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-03	N/A	4E-05	2E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	5E-03	N/A	1E-04	5E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	3E-03	N/A	6E-05	3E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	1E-03	N/A	9E-04	2E-03
			Chemical Total	2E-06	N/A	2E-07	2E-06		1E+00	N/A	9E-02	1E+00
		Exposure Point Total							2E-06			
Exposure Medium Total							2E-06					1E+00
Surface and Subsurface Soil Total							2E-06					1E+00
Receptor Total							2E-06	Receptor HI Total				1E+00

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Neurological HI Across All Media =	4E-03
Total Blood HI Across All Media =	1E-03
Total Billiary Tract HI Across All Media =	1E-03
Total Spleen HI Across All Media =	1E-03
Total Liver HI Across All Media =	1E+00
Total Skin HI Across All Media =	5E-03
Total Vascular HI Across All Media =	5E-03
Total Thyroid HI Across All Media =	2E-03
Total Gastrointestinal HI Across All Media =	5E-03
Total Hair HI Across All Media =	3E-03
Total Bone Marrow HI Across All Media =	1E-02
Total Kidney HI Across All Media =	2E-03

TABLE 9.6.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	4E-09	N/A	1E-09	5E-09	Blood	1E-04	N/A	4E-05	2E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Blood	3E-04	N/A	1E-04	4E-04
			2,4,6-Trinitrotoluene	5E-07	N/A	5E-08	5E-07	Liver	2E+00	N/A	2E-01	2E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	7E-04	N/A	2E-05	8E-04
			2-Nitrotoluene	6E-08	N/A	2E-08	9E-08	Spleen, Blood	2E-03	N/A	7E-04	3E-03
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	1E-03	N/A	3E-05	1E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	4E-03	N/A	2E-04	5E-03
			Arsenic	5E-08	N/A	6E-09	6E-08	Skin	8E-03	N/A	9E-04	9E-03
			Chromium (hexavalent)	3E-09	N/A	4E-09	7E-09	Blood	8E-05	N/A	1E-04	2E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	4E-04	N/A	1E-05	4E-04
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	9E-03	N/A	3E-04	1E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	1E-03	N/A	4E-05	1E-03
			Vanadium	N/A	N/A	N/A	N/A	Blood	1E-03	N/A	1E-03	2E-03
				Chemical Total	6E-07	N/A	9E-08	7E-07		2E+00	N/A	2E-01
	Exposure Point Total					7E-07					2E+00	
	Exposure Medium Total					7E-07					2E+00	
Surface and Subsurface Soil Total						7E-07					2E+00	
Receptor Total						7E-07	Receptor HI Total				2E+00	

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Blood HI Across All Media =	8E-03
Total Liver HI Across All Media =	2E+00
Total Neurological HI Across All Media =	6E-03
Total Skin HI Across All Media =	9E-03
Total Thyroid HI Across All Media =	4E-04
Total Gastrointestinal HI Across All Media =	1E-02
Total Hair HI Across All Media =	1E-03
Total Biliary Tract HI Across All Media =	2E-03
Total Spleen HI Across All Media =	3E-03

TABLE 9.7.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	2E-04	N/A	7E-05	3E-04
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	9E-04	N/A	3E-04	1E-03
			2,4,6-Trinitrotoluene	N/A	N/A	N/A	N/A	Liver	1E+00	N/A	1E-01	1E+00
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	4E-04	N/A	8E-06	4E-04
			2-Nitrotoluene	N/A	N/A	N/A	N/A	Bone Marrow	1E-02	N/A	4E-03	2E-02
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	5E-04	N/A	1E-05	6E-04
			Aluminum	N/A	N/A	N/A	N/A	Neurological	3E-03	N/A	8E-05	3E-03
			Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	5E-03	N/A	4E-04	5E-03
			Chromium (hexavalent)	N/A	N/A	N/A	N/A	NOE	8E-05	N/A	9E-05	2E-04
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	2E-03	N/A	6E-05	2E-03
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	5E-03	N/A	2E-04	5E-03
			Thallium	N/A	N/A	N/A	N/A	Hair	3E-03	N/A	8E-05	3E-03
			Vanadium	N/A	N/A	N/A	N/A	Kidney	1E-03	N/A	1E-03	2E-03
		Chemical Total	N/A	N/A	N/A	N/A		1E+00	N/A	1E-01	1E+00	
Exposure Point Total						N/A					1E+00	
Exposure Medium Total							N/A					1E+00
Surface and Subsurface Soil Total							N/A					1E+00
Groundwater	Groundwater	Tap Water	Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	1E+00	N/A	8E-03	1E+00
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	7E-02	N/A	2E-04	7E-02
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	3E-01	N/A	2E-03	3E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	6E-01	N/A	4E-03	6E-01
			Manganese	N/A	N/A	N/A	N/A	Neurological	2E-01	N/A	3E-02	2E-01
		Chemical Total	N/A	N/A	N/A	N/A		2E+00	N/A	4E-02	3E+00	
Exposure Point Total						N/A					3E+00	
Exposure Medium Total							N/A					3E+00
Groundwater Total							N/A					3E+00
Receptor Total							N/A	Receptor HI Total				4E+00

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	2E-01
Total Blood HI Across All Media =	1E-03
Total Billiary Tract HI Across All Media =	1E-03
Total Spleen HI Across All Media =	1E-03
Total Liver HI Across All Media =	1E+00
Total Skin HI Across All Media =	1E+00
Total Vascular HI Across All Media =	1E+00
Total Thyroid HI Across All Media =	7E-02
Total Gastrointestinal HI Across All Media =	6E-01
Total Hair HI Across All Media =	3E-03
Total Reproductive HI Across All Media =	3E-01
Total Bone Marrow HI Across All Media =	2E-02
Total Kidney HI Across All Media =	2E-03

TABLE 9.8.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	3E-03	N/A	7E-04	4E-03
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A	Spleen	1E-02	N/A	3E-03	1E-02
			2,4,6-Trinitrotoluene	N/A	N/A	N/A	N/A	Liver	2E+01	N/A	1E+00	2E+01
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	5E-03	N/A	7E-05	5E-03
			2-Nitrotoluene	N/A	N/A	N/A	N/A	Bone Marrow	2E-01	N/A	4E-02	2E-01
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A	Neurological, Blood, Biliary Tract	7E-03	N/A	1E-04	7E-03
			Aluminum	N/A	N/A	N/A	N/A	Neurological	3E-02	N/A	7E-04	3E-02
			Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	6E-02	N/A	4E-03	6E-02
			Chromium (hexavalent)	N/A	N/A	N/A	N/A	NOE	9E-04	N/A	9E-04	2E-03
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	3E-02	N/A	6E-04	3E-02
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	7E-02	N/A	2E-03	7E-02
			Thallium	N/A	N/A	N/A	N/A	Hair	3E-02	N/A	8E-04	4E-02
			Vanadium	N/A	N/A	N/A	N/A	Kidney	1E-02	N/A	1E-02	3E-02
			Chemical Total	N/A	N/A	N/A	N/A		2E+01	N/A	1E+00	2E+01
	Exposure Point Total					N/A					2E+01	
Exposure Medium Total						N/A					2E+01	
Surface and Subsurface Soil Total						N/A					2E+01	
Groundwater	Groundwater	Tap Water	Arsenic	N/A	N/A	N/A	N/A	Skin, Vascular	2E+00	N/A	2E-02	2E+00
			Cobalt	N/A	N/A	N/A	N/A	Thyroid	1E-01	N/A	4E-04	1E-01
			Cyanide	N/A	N/A	N/A	N/A	Reproductive	5E-01	N/A	4E-03	5E-01
			Iron	N/A	N/A	N/A	N/A	Gastrointestinal	1E+00	N/A	8E-03	1E+00
			Manganese	N/A	N/A	N/A	N/A	Neurological	3E-01	N/A	6E-02	4E-01
	Chemical Total	N/A	N/A	N/A	N/A		4E+00	N/A	9E-02	4E+00		
Exposure Point Total					N/A					4E+00		
Exposure Medium Total						N/A					4E+00	
Groundwater Total						N/A					4E+00	
Receptor Total						N/A	Receptor HI Total				2E+01	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Neurological HI Across All Media =	4E-01
Total Blood HI Across All Media =	2E-02
Total Billiary Tract HI Across All Media =	2E-02
Total Spleen HI Across All Media =	1E-02
Total Liver HI Across All Media =	2E+01
Total Skin HI Across All Media =	2E+00
Total Vascular HI Across All Media =	2E+00
Total Thyroid HI Across All Media =	1E-01
Total Gastrointestinal HI Across All Media =	1E+00
Total Hair HI Across All Media =	4E-02
Total Reproductive HI Across All Media =	5E-01
Total Bone Marrow HI Across All Media =	2E-01
Total Kidney HI Across All Media =	3E-02

TABLE 9.9.CTE  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4-Dinitrotoluene	2E-07	N/A	4E-08	2E-07		N/A	N/A	N/A	N/A
			1,3-Dinitrobenzene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	
			2,4,6-Trinitrotoluene	2E-05	N/A	2E-06	2E-05		N/A	N/A	N/A	N/A
			2-Amino-4,6-dinitrotoluene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			2-Nitrotoluene	3E-06	N/A	7E-07	4E-06		N/A	N/A	N/A	N/A
			4-Amino-2,6-dinitrotoluene	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Aluminum	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Arsenic	3E-06	N/A	2E-07	3E-06		N/A	N/A	N/A	N/A
			Chromium (hexavalent)	7E-07	N/A	6E-07	1E-06		N/A	N/A	N/A	N/A
			Cobalt	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Iron	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Thallium	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
			Vanadium	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
		Chemical Total	3E-05	N/A	3E-06	3E-05		N/A	N/A	N/A	N/A	
	Exposure Point Total					3E-05					N/A	
	Exposure Medium Total					3E-05					N/A	
Surface and Subsurface Soil Total						3E-05					N/A	
Groundwater	Groundwater	Tap Water	Arsenic	2E-04	N/A	1E-06	2E-04		N/A	N/A	N/A	N/A
			Cobalt	N/A	N/A	N/A	N/A		N/A	N/A	N/A	
			Cyanide	N/A	N/A	N/A	N/A		N/A	N/A	N/A	
			Iron	N/A	N/A	N/A	N/A		N/A	N/A	N/A	
		Manganese	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Chemical Total	2E-04	N/A	1E-06	2E-04		N/A	N/A	N/A	N/A		
	Exposure Point Total					2E-04					N/A	
	Exposure Medium Total					2E-04					N/A	
Groundwater Total						2E-04					N/A	
Receptor Total						2E-04	Receptor HI Total				N/A	

Notes:  
N/A = Not applicable  
HI = Hazard Index

TABLE 10.1.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4,6-Trinitrotoluene					Liver	1E+01	N/A	1E+00	1E+01
			Chemical Total					1E+01	N/A	1E+00	1E+01	
		Exposure Point Total									1E+01	
		Exposure Medium Total									1E+01	
	Surface Soil Total									1E+01		
Receptor Total									Receptor HI Total			1E+01

Notes:

N/A = Not applicable

HI = Hazard Index

Total Liver HI Across All Media = 1E+01

TABLE 10.2.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4,6-Trinitrotoluene					Liver	2E+00	N/A	3E-01	3E+00
			Chemical Total					2E+00	N/A	3E-01	3E+00	
		Exposure Point Total								3E+00		
		Exposure Medium Total								3E+00		
	Surface Soil Total										3E+00	
Receptor Total							Receptor HI Total			3E+00		

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 3E+00

TABLE 10.3.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4,6-Trinitrotoluene					Liver	2E+01	N/A	2E+00	3E+01
			Chemical Total						2E+01	N/A	2E+00	3E+01
		Exposure Point Total									3E+01	
		Exposure Medium Total									3E+01	
	Surface Soil Total									3E+01		
Receptor Total						Receptor HI Total				3E+01		

Notes:

N/A = Not applicable

HI = Hazard Index

Total Liver HI Across All Media = 3E+01

TABLE 10.4.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	4E+00	N/A	5E-01	4E+00
			Chemical Total					4E+00	N/A	5E-01	4E+00	
		Exposure Point Total									4E+00	
		Exposure Medium Total									4E+00	
	Surface and Subsurface Soil Total									4E+00		
Receptor Total							Receptor HI Total			4E+00		

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 4E+00

TABLE 10.5.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	1E+01	N/A	8E-01	1E+01
			Chemical Total					1E+01	N/A	8E-01	1E+01	
		Exposure Point Total									1E+01	
		Exposure Medium Total									1E+01	
	Surface and Subsurface Soil Total									1E+01		
Receptor Total							Receptor HI Total			1E+01		

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 1E+01

TABLE 10.6.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	7E+00	N/A	7E-01	8E+00
			Chemical Total					7E+00	N/A	7E-01	8E+00	
		Exposure Point Total									8E+00	
		Exposure Medium Total									8E+00	
	Surface and Subsurface Soil Total									8E+00		
Receptor Total								Receptor HI Total			8E+00	

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 8E+00

TABLE 10.7.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	6E+00	N/A	8E-01	7E+00
			Chemical Total						6E+00	N/A	8E-01	7E+00
		Exposure Point Total										7E+00
	Exposure Medium Total										7E+00	
	Surface and Subsurface Soil Total										7E+00	
Groundwater	Groundwater	Tap Water	Arsenic Iron					Skin, Vascular Gastrointestinal	3E+00 2E+00	N/A N/A	2E-02 9E-03	3E+00 2E+00
			Chemical Total						5E+00	N/A	3E-02	5E+00
		Exposure Point Total										5E+00
	Exposure Medium Total										5E+00	
Groundwater Total										5E+00		
Receptor Total							Receptor HI Total				1E+01	

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media =	7E+00
Total Skin HI Across All Media =	3E+00
Total Vascular HI Across All Media =	3E+00
Total Gastrointestinal HI Across All Media =	2E+00

TABLE 10.8.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient							
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total			
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene Arsenic Iron					Liver Skin, Vascular Gastrointestinal	7E+01 3E-01 3E-01	N/A N/A N/A	6E+00 2E-02 8E-03	7E+01 3E-01 3E-01			
				Chemical Total								7E+01	N/A	6E+00	7E+01
				Exposure Point Total									7E+01		
				Exposure Medium Total									7E+01		
	Surface and Subsurface Soil Total									7E+01					
Groundwater	Groundwater	Tap Water	Arsenic Iron					Skin, Vascular Gastrointestinal	5E+00 3E+00	N/A N/A	2E-02 1E-02	5E+00 3E+00			
				Chemical Total								8E+00	N/A	4E-02	8E+00
				Exposure Point Total									8E+00		
	Exposure Medium Total									8E+00					
Groundwater Total									8E+00						
Receptor Total						Receptor HI Total			8E+01						

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media =	7E+01
Total Skin HI Across All Media =	6E+00
Total Vascular HI Across All Media =	6E+00
Total Gastrointestinal HI Across All Media =	3E+00

TABLE 10.9.RME  
RISK SUMMARY  
REASONABLE MAXIMUM EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene	1E-04	N/A	1E-05	1E-04					
			2-Nitrotoluene	2E-05	N/A	5E-06	2E-05					
			Arsenic	1E-05	N/A	1E-06	1E-05					
			Chromium (hexavalent)	3E-06	N/A	3E-06	7E-06					
		Chemical Total	1E-04	N/A	2E-05	2E-04						
		Exposure Point Total						2E-04				
	Exposure Medium Total						2E-04					
Surface and Subsurface Soil Total							2E-04					
Groundwater	Groundwater	Tap Water	Arsenic	6E-04	N/A	3E-06	6E-04					
			Chemical Total	6E-04	N/A	3E-06	6E-04					
			Exposure Point Total						6E-04			
		Exposure Medium Total						6E-04				
Groundwater Total							6E-04					
Receptor Total							8E-04					

Notes:  
N/A = Not applicable

TABLE 10.1.CTE  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4,6-Trinitrotoluene					Liver	5E+00	N/A	2E-01	5E+00
			Chemical Total					5E+00	N/A	2E-01	5E+00	
		Exposure Point Total									5E+00	
		Exposure Medium Total									5E+00	
		Surface Soil Total									5E+00	
Receptor Total						Receptor HI Total					5E+00	

Notes:

N/A = Not applicable

HI = Hazard Index

Total Liver HI Across All Media = 5E+00

TABLE 10.2.CTE  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Current  
Receptor Population: Recreational User  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Surface Soil	2,4,6-Trinitrotoluene					Liver	3E+00	N/A	2E-01	3E+00
			Chemical Total						3E+00	N/A	2E-01	3E+00
		Exposure Point Total								3E+00		
	Exposure Medium Total								3E+00			
	Surface Soil Total								3E+00			
Receptor Total						Receptor HI Total			3E+00			

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 3E+00

TABLE 10.3.RME  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Base Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	2E+00	N/A	9E-02	2E+00
			Chemical Total					2E+00	N/A	9E-02	2E+00	
		Exposure Point Total							2E+00			
		Exposure Medium Total							2E+00			
		Surface and Subsurface Soil Total							2E+00			
Receptor Total								Receptor HI Total				2E+00

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 2E+00

TABLE 10.4.CTE  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	2E+00	N/A	2E-01	2E+00
			Chemical Total					2E+00	N/A	2E-01	2E+00	
		Exposure Point Total									2E+00	
	Exposure Medium Total									2E+00		
	Surface and Subsurface Soil Total									2E+00		
Receptor Total							Receptor HI Total			2E+00		

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media = 2E+00

TABLE 10.5.CTE  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene					Liver	2E+01	N/A	1E+00	2E+01
			Chemical Total						2E+01	N/A	1E+00	2E+01
		Exposure Point Total										2E+01
	Exposure Medium Total										2E+01	
	Surface and Subsurface Soil Total										2E+01	
Groundwater	Groundwater	Tap Water	Arsenic					Skin, Vascular	2E+00	N/A	2E-02	2E+00
			Chemical Total						2E+00	N/A	2E-02	2E+00
		Exposure Point Total										2E+00
	Exposure Medium Total										2E+00	
Groundwater Total										2E+00		
Receptor Total								Receptor HI Total			2E+01	

Notes:  
N/A = Not applicable  
HI = Hazard Index

Total Liver HI Across All Media =	2E+01
Total Skin HI Across All Media =	2E+00
Total Vascular HI Across All Media =	2E+00

TABLE 10.6.CTE  
RISK SUMMARY  
CENTRAL TENDENCY EXPOSURE  
AOC 6 TNT Subareas - Remedial Investigation  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil	2,4,6-Trinitrotoluene	2E-05	N/A	2E-06	2E-05					
			2-Nitrotoluene	3E-06	N/A	7E-07	4E-06					
			Arsenic	3E-06	N/A	2E-07	3E-06					
		Chemical Total	3E-05	N/A	3E-06	3E-05						
		Exposure Point Total						3E-05				
	Exposure Medium Total						3E-05					
Surface and Subsurface Soil Total							3E-05					
Groundwater	Groundwater	Tap Water	Arsenic	2E-04	N/A	1E-06	2E-04					
			Chemical Total	2E-04	N/A	1E-06	2E-04					
			Exposure Point Total						2E-04			
		Exposure Medium Total						2E-04				
Groundwater Total							2E-04					
Receptor Total							2E-04					

Notes:  
N/A = Not applicable

**TABLE 11.1a**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas - Surface Soil Across Site – Base Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	122.6	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.1b
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface soil; See Table 3.1.RME
What was the point of exposure and location?	AOC 6 TNT Subareas surface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.1b
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 219 days/year was used for the base worker scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface Soil	An input concentration value of 122.6 ppm in surface soil results in geometric mean blood lead levels ranging from 1.2 to 1.7 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.8 to 5.1 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.007% to 0.5%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.1b**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT Subareas - Surface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface Soil Across Site
Receptor: Base Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	122.6	122.6
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05	0.05
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	219	219
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
<b><math>PbB_{\text{adult}}</math></b>	<b>PbB of adult worker, geometric mean</b>	<b>ug/dL</b>	<b>1.2</b>	<b>1.7</b>
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.8	5.1
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
<b><math>P(PbB_{\text{fetal}} &gt; PbB_t)</math></b>	<b>Probability that fetal PbB &gt; <math>PbB_t</math>, assuming lognormal distribution</b>	<b>%</b>	<b>0.007%</b>	<b>0.5%</b>

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.1c**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas – Catch Box Ruins Surface Soil – Base Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	840	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.1d
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in Catch Box Ruins surface soil
What was the point of exposure and location?	AOC 6 TNT Catch Box Ruins surface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.1d
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 219 days/year was used for the base worker scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface Soil	An input concentration value of 840 ppm in surface soil results in geometric mean blood lead levels ranging from 2.2 to 2.7 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 5.2 to 8.3 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.3% to 2.9%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.1d**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT - Catch Box Ruins Surface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface Soil - Catch Box Ruins
Receptor: Base Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	840	840
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05	0.05
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	219	219
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
<b><math>PbB_{\text{adult}}</math></b>	<b>PbB of adult worker, geometric mean</b>	<b>ug/dL</b>	<b>2.2</b>	<b>2.7</b>
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	5.2	8.3
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
<b><math>P(PbB_{\text{fetal}} &gt; PbB_t)</math></b>	<b>Probability that fetal PbB &gt; <math>PbB_t</math>, assuming lognormal distribution</b>	<b>%</b>	<b>0.300%</b>	<b>2.9%</b>

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.2a**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas - Surface Soil Across Site – Adult Recreational User**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	122.6	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.2b
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface soil; See Table 3.1.RME
What was the point of exposure and location?	AOC 6 TNT Subareas surface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.2b
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 26 days/year was used for the recreational scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. A value of 20 mg/day was used for the recreational scenario.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface Soil	An input concentration value of 122.6 ppm in surface soil results in geometric mean blood lead levels ranging from 1.0 to 1.5 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.4 to 4.6 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.002% to 0.4%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.2b**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT Subareas - Surface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface Soil Across Site
Receptor: Adult Recreational User

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	122.6	122.6
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.02	0.02
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	26	26
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
$PbB_{\text{adult}}$	PbB of adult worker, geometric mean	ug/dL	1.0	1.5
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.4	4.6
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
$P(PbB_{\text{fetal}} > PbB_t)$	Probability that fetal PbB > $PbB_t$ , assuming lognormal distribution	%	0.002%	0.4%

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.2c**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas – Catch Box Ruins Surface Soil – Adult Recreational User**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	840	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.2d
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in Catch Box Ruins surface soil
What was the point of exposure and location?	AOC 6 TNT Catch Box Ruins surface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.2d
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 26 days/year was used for the recreational scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. A value of 20 mg/day was used for the recreational scenario.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface Soil	An input concentration value of 840 ppm in surface soil results in geometric mean blood lead levels ranging from 1.1 to 1.6 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.5 to 4.8 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.003% to 0.4%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.2d**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT - Catch Box Ruins Surface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface Soil - Catch Box Ruins
Receptor: Adult Recreational User

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	840	840
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.02	0.02
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	26	26
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
$PbB_{\text{adult}}$	PbB of adult worker, geometric mean	ug/dL	1.1	1.6
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.5	4.8
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
$P(PbB_{\text{fetal}} > PbB_t)$	Probability that fetal PbB > $PbB_t$ , assuming lognormal distribution	%	0.003%	0.4%

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.3a**  
**RAGS D IEUBK LEAD WORKSHEET – AOC 6 TNT Subareas - Surface Soil Across Site, Child Recreational User**  
**Child (Age 0 – 84 Months)**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	122.6	mg/kg	Average Detected Value in Surface Soil	400	mg/kg	Recommended Soil Screening Level
Water	4	µg/L	IEUBK Model Default Value	15	µg/L	Recommended Drinking Water Action Level

**2. Lead Model Questions**

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.1 Build 11 (February, 2010)
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Table 11.3b and Figure 11.1)
What range of media concentrations were used for the model?	9.9– 1,100 mg/kg (surface soil)
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface soil; See Table 3.1.RME
Was soil sample taken from top 2 cm? If not, why?	Yes
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Samples were collected for multiple analyses.
What was the point of exposure/location?	AOC 6 TNT Subareas surface soil.
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Table 11.3b and Figure 11.1)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in surface soil.
Was the default soil bioavailability used?	Yes -- Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	In the HHRA section of the report.

**3. Final Result**

Medium	Result	Comment/PRG <sup>1</sup>
Surface Soil	Input value of 122.6 mg/kg in surface soil results in <0.04% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 2.0 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

1. For additional information, see [www.epa.gov/superfund/health/contaminants/lead](http://www.epa.gov/superfund/health/contaminants/lead)

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

Table 11.3b  
 AOC 6 TNT Subareas - Surface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

LEAD MODEL FOR WINDOWS Version 1.1

```
=====
Model Version: 1.1 Build11
User Name: CH2M HILL
Date: 5/14/2014
Site Name: Naval Weapons Station Yorktown Cheatham Annex
Operable Unit: AOC 6 TNT Subareas
Run Mode: Site Risk Assessment
=====
```

\*\*\*\*\* Air \*\*\*\*\*

Indoor Air Pb Concentration: 30.000 percent of outdoor.  
 Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m <sup>3</sup> /day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m <sup>3</sup> )
-----				
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

\*\*\*\*\* Diet \*\*\*\*\*

Age	Diet Intake(µg/day)
-----	
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Table 11.3b

AOC 6 TNT Subareas - Surface Soil Across Site

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

\*\*\*\*\* Drinking Water \*\*\*\*\*

Water Consumption:

Age    Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

\*\*\*\*\* Soil & Dust \*\*\*\*\*

Multiple Source Analysis Used

Average multiple source concentration: 95.820 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age            Soil (µg Pb/g)            House Dust (µg Pb/g)

.5-1	122.600	95.820
1-2	122.600	95.820
2-3	122.600	95.820
3-4	122.600	95.820
4-5	122.600	95.820
5-6	122.600	95.820
6-7	122.600	95.820

\*\*\*\*\* Alternate Intake \*\*\*\*\*

Age    Alternate (µg Pb/day)

.5-1	0.000
1-2	0.000

Table 11.3b

AOC 6 TNT Subareas - Surface Soil Across Site

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

2-3 0.000  
 3-4 0.000  
 4-5 0.000  
 5-6 0.000  
 6-7 0.000

\*\*\*\*\* Maternal Contribution: Infant Model \*\*\*\*\*

Maternal Blood Concentration: 1.000 µg Pb/dL

\*\*\*\*\*

## CALCULATED BLOOD LEAD AND LEAD UPTAKES:

\*\*\*\*\*

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
-----				
.5-1	0.021	1.079	0.000	0.382
1-2	0.034	0.930	0.000	0.949
2-3	0.062	1.017	0.000	0.993
3-4	0.067	0.981	0.000	1.019
4-5	0.067	0.948	0.000	1.069
5-6	0.093	1.001	0.000	1.132
6-7	0.093	1.086	0.000	1.154

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
-----			
.5-1	2.626	4.108	2.2
1-2	4.145	6.057	2.5
2-3	4.173	6.245	2.3
3-4	4.201	6.267	2.2
4-5	3.146	5.230	1.9
5-6	2.843	5.070	1.6
6-7	2.691	5.025	1.4

**TABLE 11.3c**  
**RAGS D IEUBK LEAD WORKSHEET – AOC 6 TNT Subareas – Catch Box Ruins Surface Soil, Child Recreational User**  
**Child (Age 0 – 84 Months)**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	840	mg/kg	Average Detected Value in Catch Box Ruins Surface Soil	400	mg/kg	Recommended Soil Screening Level
Water	4	µg/L	IEUBK Model Default Value	15	µg/L	Recommended Drinking Water Action Level

**2. Lead Model Questions**

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.1 Build 11 (February, 2010)
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Table 11.3d and Figure 11.2)
What range of media concentrations were used for the model?	580– 1,100 mg/kg (surface soil)
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in catch box ruins surface soil
Was soil sample taken from top 2 cm? If not, why?	Yes
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Samples were collected for multiple analyses.
What was the point of exposure/location?	AOC 6 TNT catch box ruins surface soil.
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Table 11.3d and Figure 11.2)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in surface soil.
Was the default soil bioavailability used?	Yes -- Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	In the HHRA section of the report.

**3. Final Result**

Medium	Result	Comment/PRG <sup>1</sup>
Surface Soil	Input value of 840 mg/kg in surface soil results in 30% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 7.8 µg/dL. This is above the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

1. For additional information, see [www.epa.gov/superfund/health/contaminants/lead](http://www.epa.gov/superfund/health/contaminants/lead)

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

Table 11.3d  
 AOC 6 TNT Subareas - Catch Box Ruins Surface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

LEAD MODEL FOR WINDOWS Version 1.1

```
=====
Model Version: 1.1 Build11
User Name: CH2M HILL
Date: 5/20/2015
Site Name: Naval Weapons Station Yorktown Cheatham Annex
Operable Unit: AOC 6 TNT Catch Box Ruins
Run Mode: Site Risk Assessment
=====
```

\*\*\*\*\* Air \*\*\*\*\*

Indoor Air Pb Concentration: 30.000 percent of outdoor.  
 Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m <sup>3</sup> /day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m <sup>3</sup> )
-----				
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

\*\*\*\*\* Diet \*\*\*\*\*

Age	Diet Intake(µg/day)
-----	
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Table 11.3d

AOC 6 TNT Subareas - Catch Box Ruins Surface Soil

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

\*\*\*\*\* Drinking Water \*\*\*\*\*

Water Consumption:

Age    Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

\*\*\*\*\* Soil & Dust \*\*\*\*\*

Multiple Source Analysis Used

Average multiple source concentration: 598.000 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.0

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
-----	----------------	----------------------

.5-1	840.000	598.000
1-2	840.000	598.000
2-3	840.000	598.000
3-4	840.000	598.000
4-5	840.000	598.000
5-6	840.000	598.000
6-7	840.000	598.000

\*\*\*\*\* Alternate Intake \*\*\*\*\*

Age	Alternate (µg Pb/day)
-----	-----------------------

.5-1	0.000
1-2	0.000

Table 11.3d

AOC 6 TNT Subareas - Catch Box Ruins Surface Soil

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

2-3 0.000  
 3-4 0.000  
 4-5 0.000  
 5-6 0.000  
 6-7 0.000

\*\*\*\*\* Maternal Contribution: Infant Model \*\*\*\*\*

Maternal Blood Concentration: 1.000 µg Pb/dL

\*\*\*\*\*

## CALCULATED BLOOD LEAD AND LEAD UPTAKES:

\*\*\*\*\*

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
-----				
.5-1	0.021	0.936	0.000	0.331
1-2	0.034	0.785	0.000	0.801
2-3	0.062	0.878	0.000	0.857
3-4	0.067	0.862	0.000	0.895
4-5	0.067	0.869	0.000	0.980
5-6	0.093	0.932	0.000	1.055
6-7	0.093	1.021	0.000	1.085

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
-----			
.5-1	14.925	16.213	8.6
1-2	22.944	24.565	10.0
2-3	23.592	25.389	9.3
3-4	24.185	26.009	9.0
4-5	18.897	20.812	7.4
5-6	17.356	19.436	6.2
6-7	16.573	18.772	5.4

**TABLE 11.4a**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site– Base Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	80.44	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.4b
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface and subsurface soil; See Table 3.2.RME
What was the point of exposure and location?	AOC 6 TNT Subareas surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.4b
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 219 days/year was used for the base worker scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 80.44 ppm in surface and subsurface soil results in geometric mean blood lead levels ranging from 1.1 to 1.6 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.6 to 4.9 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.005% to 0.5%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.4b**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface and Subsurface Soil Across Site
Receptor: Base Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	80.44	80.44
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05	0.05
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	219	219
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
<b><math>PbB_{\text{adult}}</math></b>	<b>PbB of adult worker, geometric mean</b>	<b>ug/dL</b>	<b>1.1</b>	<b>1.6</b>
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.6	4.9
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
<b><math>P(PbB_{\text{fetal}} &gt; PbB_t)</math></b>	<b>Probability that fetal PbB &gt; <math>PbB_t</math>, assuming lognormal distribution</b>	<b>%</b>	<b>0.005%</b>	<b>0.5%</b>

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.4c**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas – Catch Box Ruins Surface and Subsurface Soil– Base Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	543.75	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.4d
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in catch box ruins surface and subsurface soil
What was the point of exposure and location?	AOC 6 TNT catch box ruins surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.4d
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 219 days/year was used for the base worker scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 543.75 ppm in surface and subsurface soil results in geometric mean blood lead levels ranging from 1.8 to 2.3 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 4.2 to 7.0 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.093% to 1.6%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.4d**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT - Catch Box Ruins Surface and Subsurface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Catch Box Ruins Surface and Subsurface Soil
Receptor: Base Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	543.75	543.75
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05	0.05
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	219	219
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
$PbB_{\text{adult}}$	PbB of adult worker, geometric mean	ug/dL	1.8	2.3
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	4.2	7.0
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
$P(PbB_{\text{fetal}} > PbB_t)$	Probability that fetal PbB > $PbB_t$ , assuming lognormal distribution	%	0.093%	1.6%

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.5a**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site – Adult**  
**Recreational User**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	80.44	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.5b
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface and subsurface soil; See Table 3.2.RME
What was the point of exposure and location?	AOC 6 TNT Subareas surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.5b
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 26 days/year was used for the recreational scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. A value of 20 mg/day was used for the recreational scenario.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 80.44 ppm in surface and subsurface soil results in geometric mean blood lead levels ranging from 1.0 to 1.5 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.4 to 4.6 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.002% to 0.4%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.5b**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface and Subsurface Soil Across Site
Receptor: Adult Recreational User

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	80.44	80.44
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.02	0.02
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	26	26
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
<b><math>PbB_{\text{adult}}</math></b>	<b>PbB of adult worker, geometric mean</b>	<b>ug/dL</b>	<b>1.0</b>	<b>1.5</b>
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.4	4.6
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
<b><math>P(PbB_{\text{fetal}} &gt; PbB_t)</math></b>	<b>Probability that fetal PbB &gt; <math>PbB_t</math>, assuming lognormal distribution</b>	<b>%</b>	<b>0.002%</b>	<b>0.4%</b>

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee  
 Version date 6/21/09

**TABLE 11.5c**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas – Catch Box Ruins Surface and Subsurface Soil – Adult**  
**Recreational User**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	543.75	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Table 11.5d
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in catch basin ruins surface and subsurface soil
What was the point of exposure and location?	AOC 6 TNT catch basin ruins surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.5d
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix.	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (Pb <sub>B0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix.	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 26 days/year was used for the recreational scenario.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. A value of 20 mg/day was used for the recreational scenario.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 543.75 ppm in surface and subsurface soil results in geometric mean blood lead levels ranging from 1.0 to 1.5 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 2.5 to 4.7 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.003% to 0.4%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.5d**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT - Catch Box Ruins Surface and Subsurface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Catch Box Ruins Surface and Subsurface Soil
Receptor: Adult Recreational User

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	543.75	543.75
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.02	0.02
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	26	26
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365
$PbB_{\text{adult}}$	PbB of adult worker, geometric mean	ug/dL	1.0	1.5
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.5	4.7
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
$P(PbB_{\text{fetal}} > PbB_t)$	Probability that fetal PbB > $PbB_t$ , assuming lognormal distribution	%	0.003%	0.4%

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09

**TABLE 11.6a**  
**RAGS D IEUBK LEAD WORKSHEET – AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site,**  
**Child (Age 0 – 84 Months)**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	80.44	mg/kg	Average Detected Value in Surface Soil	400	mg/kg	Recommended Soil Screening Level
Water	4	µg/L	IEUBK Model Default Value	15	µg/L	Recommended Drinking Water Action Level

**2. Lead Model Questions**

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.1 Build 11 (February, 2010)
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Table 11.6b and Figure 11.3)
What range of media concentrations were used for the model?	4 – 1,100 mg/kg (surface and subsurface soil)
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in surface and subsurface soil; See Table 3.2.RME
Was soil sample taken from top 2 cm? If not, why?	Yes
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Samples were collected for multiple analyses.
What was the point of exposure/location?	AOC 6 TNT Subareas surface and subsurface soil.
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Table 11.6b and Figure 11.3)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in surface and subsurface soil.
Was the default soil bioavailability used?	Yes -- Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	In the HHRA section of the report.

**3. Final Result**

Medium	Result	Comment/PRG <sup>1</sup>
Surface and subsurface Soil	Input value of 80.44 mg/kg in soil results in <0.01% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 1.6 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

1. For additional information, see [www.epa.gov/superfund/health/contaminants/lead](http://www.epa.gov/superfund/health/contaminants/lead)

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

Table 11.6b

AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

LEAD MODEL FOR WINDOWS Version 1.1

Model Version: 1.1 Build11

User Name: CH2M HILL

Date: 4/30/2014

Site Name: Naval Weapons Station Yorktown Cheatham Annex

Operable Unit: AOC 6 TNT Subareas

Run Mode: Site Risk Assessment

\*\*\*\*\* Air \*\*\*\*\*

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m <sup>3</sup> /day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m <sup>3</sup> )
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

\*\*\*\*\* Diet \*\*\*\*\*

Age Diet Intake(µg/day)

.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Table 11.6b

AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

\*\*\*\*\* Drinking Water \*\*\*\*\*

Water Consumption:

Age    Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

\*\*\*\*\* Soil & Dust \*\*\*\*\*

Multiple Source Analysis Used

Average multiple source concentration: 66.308 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.0

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
-----	----------------	----------------------

.5-1	80.440	66.308
1-2	80.440	66.308
2-3	80.440	66.308
3-4	80.440	66.308
4-5	80.440	66.308
5-6	80.440	66.308
6-7	80.440	66.308

\*\*\*\*\* Alternate Intake \*\*\*\*\*

Age	Alternate (µg Pb/day)
-----	-----------------------

.5-1	0.000
1-2	0.000

Table 11.6b

AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

2-3 0.000  
 3-4 0.000  
 4-5 0.000  
 5-6 0.000  
 6-7 0.000

\*\*\*\*\* Maternal Contribution: Infant Model \*\*\*\*\*

Maternal Blood Concentration: 1.000 µg Pb/dL

\*\*\*\*\*

## CALCULATED BLOOD LEAD AND LEAD UPTAKES:

\*\*\*\*\*

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
-----				
.5-1	0.021	1.089	0.000	0.385
1-2	0.034	0.940	0.000	0.960
2-3	0.062	1.027	0.000	1.003
3-4	0.067	0.989	0.000	1.028
4-5	0.067	0.953	0.000	1.075
5-6	0.093	1.005	0.000	1.137
6-7	0.093	1.090	0.000	1.159

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
-----			
.5-1	1.786	3.281	1.8
1-2	2.824	4.759	2.0
2-3	2.839	4.931	1.8
3-4	2.854	4.937	1.7
4-5	2.131	4.226	1.5
5-6	1.924	4.160	1.3
6-7	1.820	4.162	1.2

**TABLE 11.6c**  
**RAGS D IEUBK LEAD WORKSHEET – AOC 6 TNT – Catch Box Ruins Surface and Subsurface Soil,**  
**Child (Age 0 – 84 Months)**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	543.75	mg/kg	Average Detected Value in Surface Soil	400	mg/kg	Recommended Soil Screening Level
Water	4	µg/L	IEUBK Model Default Value	15	µg/L	Recommended Drinking Water Action Level

**2. Lead Model Questions**

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.1 Build 11 (February, 2010)
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Table 11.6d and Figure 11.4)
What range of media concentrations were used for the model?	4 – 1,100 mg/kg (surface and subsurface soil)
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure concentration was the arithmetic mean of lead concentrations in catch box ruins surface and subsurface soil
Was soil sample taken from top 2 cm? If not, why?	Yes
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Samples were collected for multiple analyses.
What was the point of exposure/location?	AOC 6 TNT Subareas surface and subsurface soil.
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Table 11.6d and Figure 11.4)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in surface and subsurface soil.
Was the default soil bioavailability used?	Yes -- Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	In the HHRA section of the report.

**3. Final Result**

Medium	Result	Comment/PRG <sup>1</sup>
Surface and subsurface Soil	Input value of 543.75 mg/kg in soil results in 11.1% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 5.6 µg/dL. This is above the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

1. For additional information, see [www.epa.gov/superfund/health/contaminants/lead](http://www.epa.gov/superfund/health/contaminants/lead)

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

Table 11.6d  
 AOC 6 TNT - Catch Box Ruins Surface and Subsurface Soil  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

LEAD MODEL FOR WINDOWS Version 1.1

```
=====
Model Version: 1.1 Build11
User Name: CH2M HILL
Date: 5/20/2015
Site Name: Naval Weapons Station Yorktown Cheatham Annex
Operable Unit: AOC 6 TNT Catch Box Ruins
Run Mode: Site Risk Assessment
=====
```

\*\*\*\*\* Air \*\*\*\*\*

Indoor Air Pb Concentration: 30.000 percent of outdoor.  
 Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m <sup>3</sup> /day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m <sup>3</sup> )
-----				
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

\*\*\*\*\* Diet \*\*\*\*\*

Age	Diet Intake(µg/day)
-----	
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Table 11.6d

AOC 6 TNT - Catch Box Ruins Surface and Subsurface Soil

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

\*\*\*\*\* Drinking Water \*\*\*\*\*

Water Consumption:

Age    Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

\*\*\*\*\* Soil & Dust \*\*\*\*\*

Multiple Source Analysis Used

Average multiple source concentration: 390.625 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.0

Use alternate indoor dust Pb sources? No

Age            Soil (µg Pb/g)            House Dust (µg Pb/g)

.5-1	543.750	390.625
1-2	543.750	390.625
2-3	543.750	390.625
3-4	543.750	390.625
4-5	543.750	390.625
5-6	543.750	390.625
6-7	543.750	390.625

\*\*\*\*\* Alternate Intake \*\*\*\*\*

Age    Alternate (µg Pb/day)

.5-1	0.000
1-2	0.000

Table 11.6d

AOC 6 TNT - Catch Box Ruins Surface and Subsurface Soil

Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

2-3 0.000  
 3-4 0.000  
 4-5 0.000  
 5-6 0.000  
 6-7 0.000

\*\*\*\*\* Maternal Contribution: Infant Model \*\*\*\*\*

Maternal Blood Concentration: 1.000 µg Pb/dL

\*\*\*\*\*

## CALCULATED BLOOD LEAD AND LEAD UPTAKES:

\*\*\*\*\*

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
-----				
.5-1	0.021	0.988	0.000	0.350
1-2	0.034	0.837	0.000	0.855
2-3	0.062	0.929	0.000	0.907
3-4	0.067	0.906	0.000	0.942
4-5	0.067	0.899	0.000	1.015
5-6	0.093	0.959	0.000	1.085
6-7	0.093	1.046	0.000	1.112

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
-----			
.5-1	10.250	11.609	6.2
1-2	15.905	17.631	7.2
2-3	16.233	18.131	6.7
3-4	16.533	18.447	6.4
4-5	12.716	14.697	5.3
5-6	11.607	13.744	4.4
6-7	11.046	13.298	3.9

**TABLE 11.7a**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site –**  
**Construction Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	80.44	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Attached as Table 11.7b
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in surface and subsurface soil; See Table 3.2.RME
What was the point of exposure and location?	AOC 6 TNT Subareas surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.7b
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 125 days/year was used for the construction worker scenario, assuming duration of construction project is one-half of a year.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. An IR value of 100 mg/day was used, based on recommendation in the Adult Lead Model FAQs. <a href="http://www.epa.gov/superfund/lead/almfaq.htm#soil">http://www.epa.gov/superfund/lead/almfaq.htm#soil</a> ingestion rate.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 80.44 ppm in surface soil and subsurface soil results in geometric mean blood lead levels ranging from 1.3 to 1.8 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 3.0 to 5.4 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.011% to 0.7%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

**Table 11.7b**

Calculations of Blood Lead Concentrations (PbBs) - AOC 6 TNT Subareas - Surface and Subsurface Soil Across Site  
 Remedial Investigation  
 Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Exposure Medium: Surface and Subsurface Soil Across Site
Receptor: Construction Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	ug/g or ppm	80.44	80.44
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	2.1
$PbB_0$	Baseline PbB	ug/dL	1.0	1.5
$IR_S$	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.1	0.1
$IR_{S+D}$	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
$W_S$	Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil	--	--	--
$K_{SD}$	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	125	125
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	182	182
$PbB_{\text{adult}}$	PbB of adult worker, geometric mean	ug/dL	1.3	1.8
$PbB_{\text{fetal}, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	3.0	5.4
$PbB_t$	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0
$P(PbB_{\text{fetal}} > PbB_t)$	Probability that fetal PbB > $PbB_t$ , assuming lognormal distribution	%	0.011%	0.7%

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee  
 Version date 6/21/09

**TABLE 11.7c**  
**RAGS D ADULT LEAD WORKSHEET**  
**Calculations of Blood Lead Concentrations – AOC 6 TNT Subareas – Catch Box Ruins Surface and Subsurface Soil –**  
**Construction Worker**  
**Remedial Investigation**  
**Naval Weapons Station Yorktown, Yorktown, Virginia**

**1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	543.75	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level

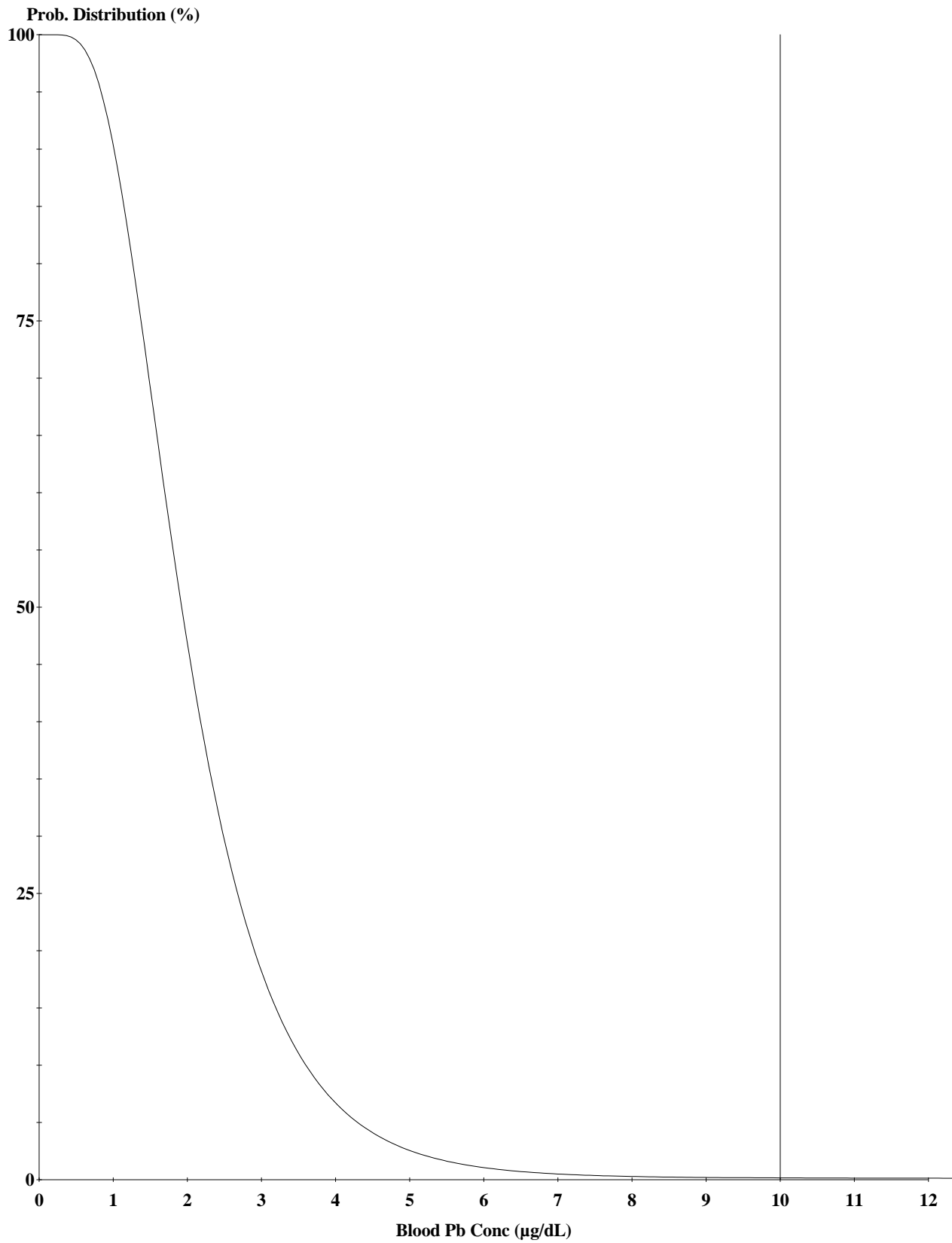
**2. Lead Model Questions**

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 6/21/2009
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Attached as Table 11.7d
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in catch box ruins surface and subsurface soil
What was the point of exposure and location?	AOC 6 TNT Subareas surface and subsurface soil
Where are the output values located in the risk assessment report?	Attached as Table 11.7d
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix	Default values were used (1.8 and 2.1).
What baseline blood lead concentration (PbB <sub>0</sub> ) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix	Default values from ALM were used (1.0 and 1.5 ug/dL).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 125 days/year was used for the construction worker scenario, assuming duration of construction project is one-half of a year.
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. An IR value of 100 mg/day was used, based on recommendation in the Adult Lead Model FAQs. <a href="http://www.epa.gov/superfund/lead/almfaq.htm#soil">http://www.epa.gov/superfund/lead/almfaq.htm#soil</a> ingestion rate.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in HHRA Section.

**3. Final Result**

Medium	Result	Comment/RBRG <sup>1</sup>
Surface and Subsurface Soil	An input concentration value of 543.75 ppm in surface soil and subsurface soil results in geometric mean blood lead levels ranging from 2.8 to 3.3 ug/dL for women of child-bearing age in homogeneous and heterogeneous populations. The 95th percentile fetal blood lead concentrations range from 6.6 to 10 ug/dL. The probabilities that the fetal blood lead levels exceed 10 ug/dL range from 0.94% to 5.1%. The upper range of these values are slightly above the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

**1. Attach the ALM or IEUBK spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see [www.epa.gov/superfund/programs/lead](http://www.epa.gov/superfund/programs/lead)**

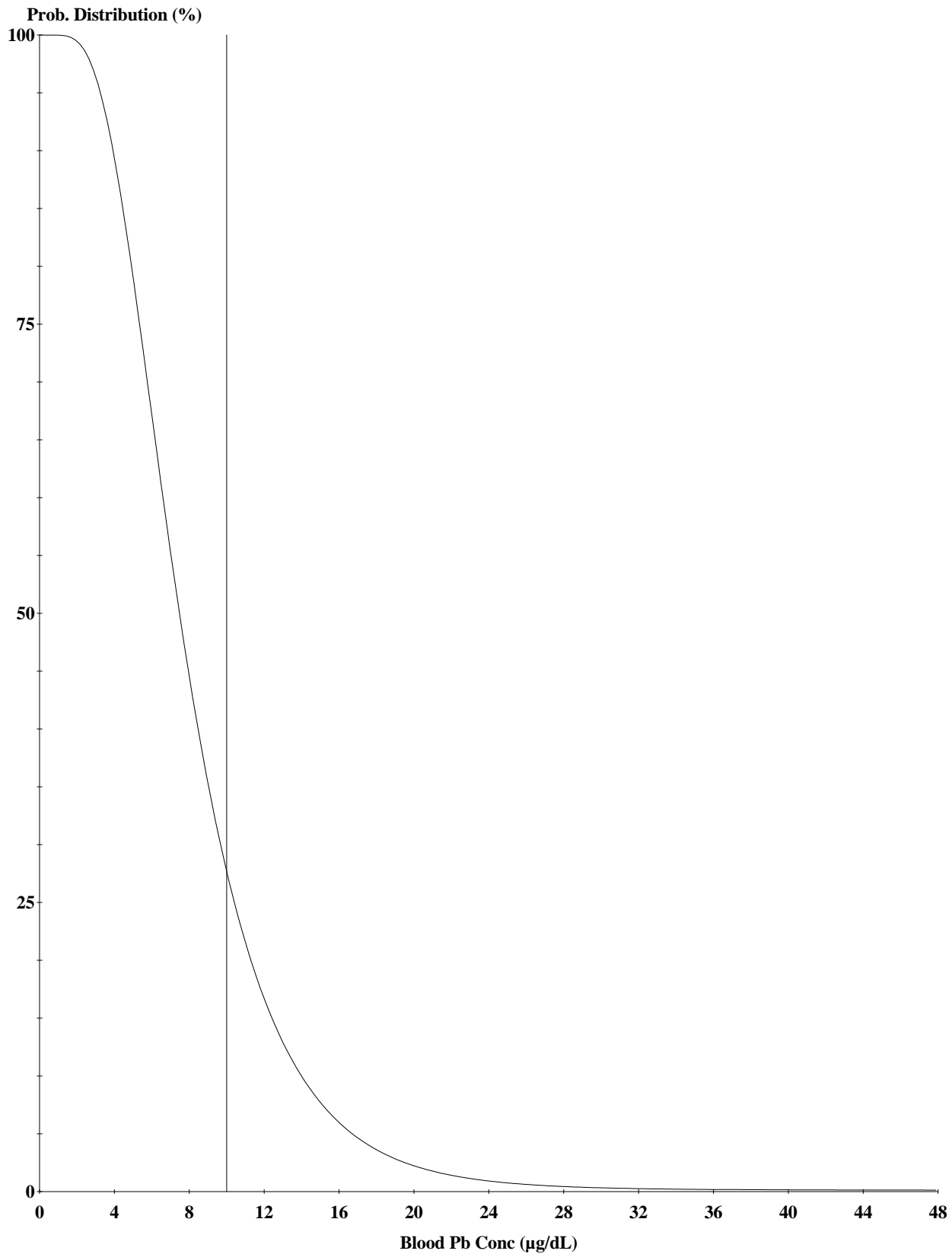


Cutoff = 10.000 µg/dl  
Geo Mean = 2.016  
GSD = 1.600  
% Above = 0.033

Age Range = 0 to 84 months

Run Mode = Research

Figure 11-1  
Surface soil across site, recreational child

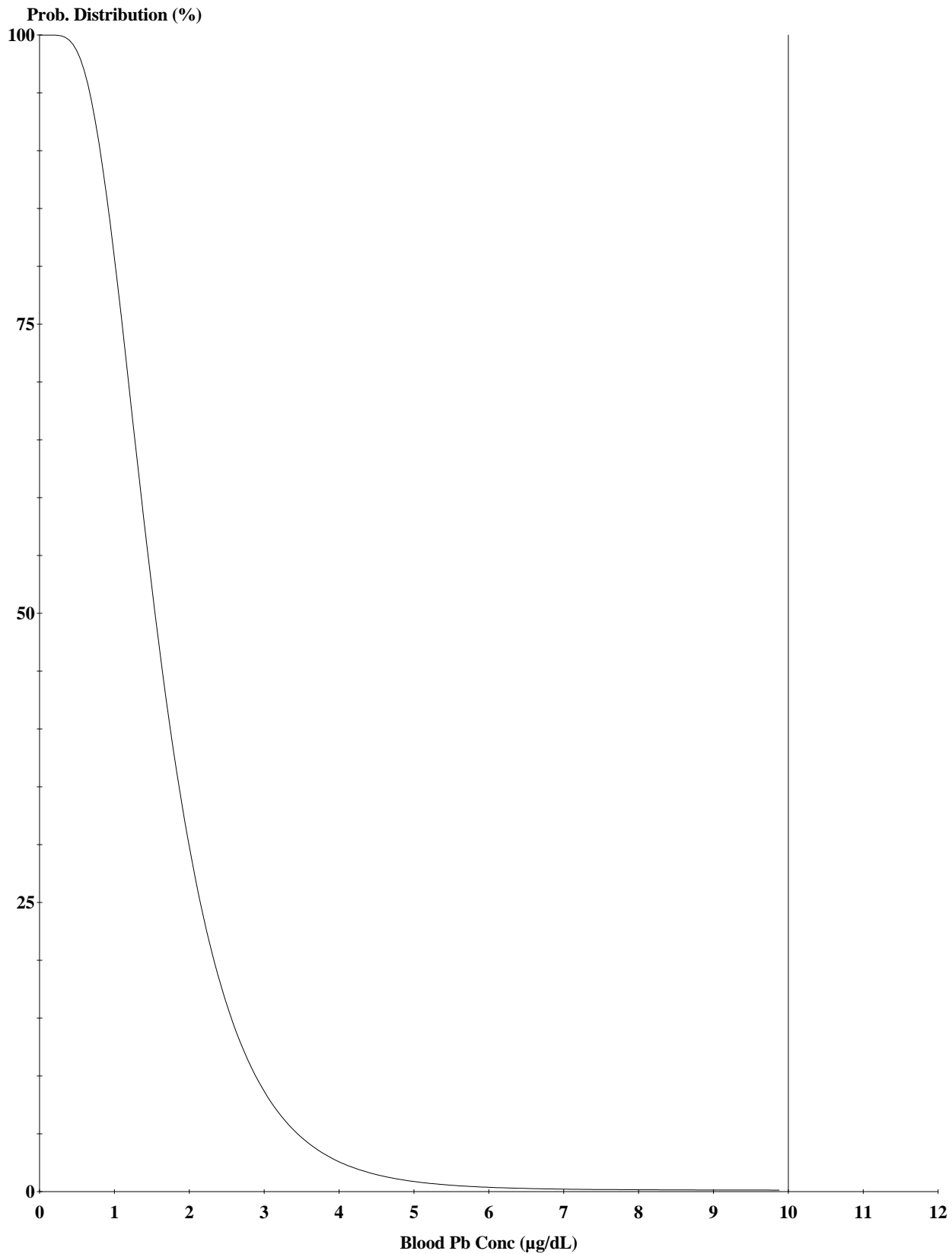


Cutoff = 10.000 µg/dl  
Geo Mean = 7.834  
GSD = 1.600  
% Above = 30.179

Age Range = 0 to 84 months

Run Mode = Research

Figure 11-2  
Catch Box Ruins Surface, recreational child

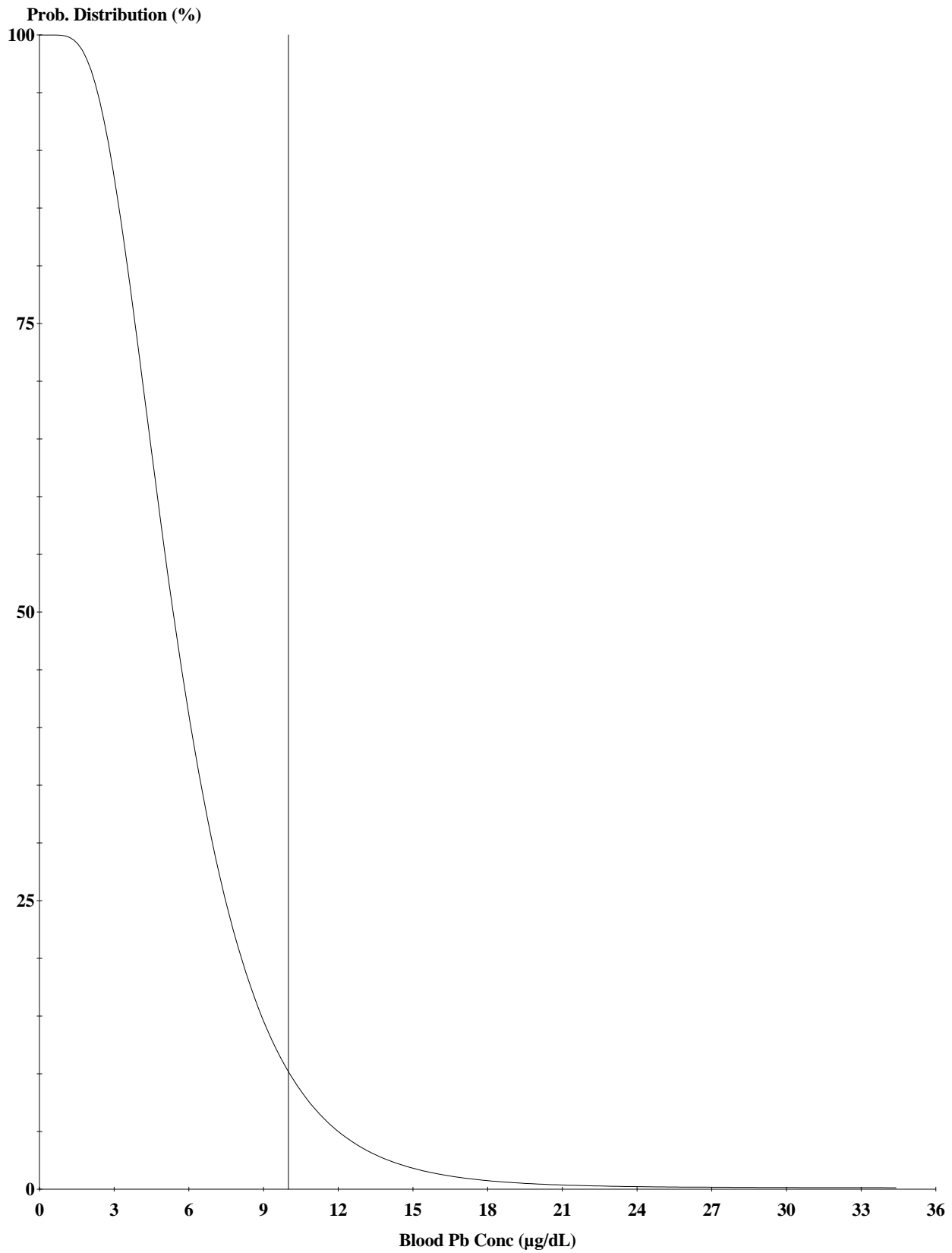


Cutoff = 10.000 µg/dl  
Geo Mean = 1.616  
GSD = 1.600  
% Above = 0.005

Age Range = 0 to 84 months

Run Mode = Research

Figure 11-3  
Recreational/Residential Child  
Soil Across Site



Cutoff = 10.000 µg/dl  
Geo Mean = 5.628  
GSD = 1.600  
% Above = 11.066

Age Range = 0 to 84 months

Run Mode = Research

Figure 11-4  
Recreational/Residential Child  
Catch Box Ruins Soil

## Appendix I

ProUCL Output - Surface Soil

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### UCL Statistics for Data Sets with Non-Detects

#### User Selected Options

Date/Time of Computation 5/7/2014 11:27:46 AM  
From File SS\_proUCL\_Cax AOC6\_input\_revision.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

#### 2,4-Dinitrotoluene

##### General Statistics

Total Number of Observations	20	Number of Distinct Observations	12
Number of Detects	5	Number of Non-Detects	15
Number of Distinct Detects	5	Number of Distinct Non-Detects	7
Minimum Detect	140	Minimum Non-Detect	99
Maximum Detect	6300	Maximum Non-Detect	460
Variance Detects	6840380	Percent Non-Detects	75%
Mean Detects	1706	SD Detects	2615
Median Detects	400	CV Detects	1.533
Skewness Detects	2.05	Kurtosis Detects	4.245
Mean of Logged Detects	6.519	SD of Logged Detects	1.499

##### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.695	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.347	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

##### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	518.5	Standard Error of Mean	339.3
SD	1356	95% KM (BCA) UCL	1201
95% KM (t) UCL	1105	95% KM (Percentile Bootstrap) UCL	1136
95% KM (z) UCL	1077	95% KM Bootstrap t UCL	4450
90% KM Chebyshev UCL	1536	95% KM Chebyshev UCL	1998
97.5% KM Chebyshev UCL	2637	99% KM Chebyshev UCL	3895

##### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.436	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.703	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.295	<b>Kolmogrov-Smirnoff GOF</b>
5% K-S Critical Value	0.368	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.66	k star (bias corrected MLE)	0.397
Theta hat (MLE)	2584	Theta star (bias corrected MLE)	4292
nu hat (MLE)	6.603	nu star (bias corrected)	3.975
MLE Mean (bias corrected)	1706	MLE Sd (bias corrected)	2706

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.146	nu hat (KM)	5.847
Approximate Chi Square Value (5.85, $\alpha$ )	1.562	Adjusted Chi Square Value (5.85, $\beta$ )	1.395
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	1941	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	2173

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	426.5
Maximum	6300	Median	0.01
SD	1419	CV	3.328
k hat (MLE)	0.103	k star (bias corrected MLE)	0.121
Theta hat (MLE)	4152	Theta star (bias corrected MLE)	3535
nu hat (MLE)	4.109	nu star (bias corrected)	4.826
MLE Mean (bias corrected)	426.5	MLE Sd (bias corrected)	1228
		Adjusted Level of Significance ( $\beta$ )	0.038
Approximate Chi Square Value (4.83, $\alpha$ )	1.072	Adjusted Chi Square Value (4.83, $\beta$ )	0.942
95% Gamma Approximate UCL (use when $n \geq 50$ )	1919	95% Gamma Adjusted UCL (use when $n < 50$ )	2185

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.943	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.238	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	457.4	Mean in Log Scale	4.061
SD in Original Scale	1410	SD in Log Scale	1.863
95% t UCL (assumes normality of ROS data)	1003	95% Percentile Bootstrap UCL	1070
95% BCA Bootstrap UCL	1458	95% Bootstrap t UCL	6467
95% H-UCL (Log ROS)	1862		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.215	95% H-UCL (KM -Log)	585.4
KM SD (logged)	1.027	95% Critical H Value (KM-Log)	2.674
KM Standard Error of Mean (logged)	0.278		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	527
------------------------	-----

#### DL/2 Log-Transformed

Mean in Log Scale	5.258
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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

SD in Original Scale	1389	SD in Log Scale	1.064
95% t UCL (Assumes normality)	1064	95% H-Stat UCL	658.1

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Approximate Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	1105	95% KM (Percentile Bootstrap) UCL	1136
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## 1,3-Dinitrobenzene

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	10
Number of Detects	4	Number of Non-Detects	16
Number of Distinct Detects	4	Number of Distinct Non-Detects	6
Minimum Detect	84	Minimum Non-Detect	99
Maximum Detect	2500	Maximum Non-Detect	390
Variance Detects	1208951	Percent Non-Detects	80%
Mean Detects	901	SD Detects	1100
Median Detects	510	CV Detects	1.22
Skewness Detects	1.66	Kurtosis Detects	2.745
Mean of Logged Detects	6.129	SD of Logged Detects	1.436

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.829	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.312	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	248	Standard Error of Mean	138.6
SD	536.7	95% KM (BCA) UCL	N/A
95% KM (t) UCL	487.7	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	476	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	663.8	95% KM Chebyshev UCL	852.2
97.5% KM Chebyshev UCL	1114	99% KM Chebyshev UCL	1627

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.227	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.669	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.404	Detected data appear Gamma Distributed at 5% Significance Level

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AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Detected data appear Gamma Distributed at 5% Significance Level

#### Gamma Statistics on Detected Data Only

k hat (MLE)	0.871	k star (bias corrected MLE)	0.384
Theta hat (MLE)	1035	Theta star (bias corrected MLE)	2344
nu hat (MLE)	6.967	nu star (bias corrected)	3.075
MLE Mean (bias corrected)	901	MLE Sd (bias corrected)	1453

#### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.214	nu hat (KM)	8.541
Approximate Chi Square Value (8.54, $\alpha$ )	3.052	Adjusted Chi Square Value (8.54, $\beta$ )	2.798
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	694	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	757.1

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	204
Maximum	2500	Median	0.01
SD	569.8	CV	2.793
k hat (MLE)	0.123	k star (bias corrected MLE)	0.138
Theta hat (MLE)	1652	Theta star (bias corrected MLE)	1475
nu hat (MLE)	4.939	nu star (bias corrected)	5.532
MLE Mean (bias corrected)	204	MLE Sd (bias corrected)	548.6
		Adjusted Level of Significance ( $\beta$ )	0.038
Approximate Chi Square Value (5.53, $\alpha$ )	1.405	Adjusted Chi Square Value (5.53, $\beta$ )	1.249
95% Gamma Approximate UCL (use when $n \geq 50$ )	803	95% Gamma Adjusted UCL (use when $n < 50$ )	N/A

#### Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.132	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level

### Detected Data appear Approximate Lognormal at 5% Significance Level

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	248.7	Mean in Log Scale	4.557
SD in Original Scale	553.5	SD in Log Scale	1.229
95% t UCL (assumes normality of ROS data)	462.8	95% Percentile Bootstrap UCL	486.4
95% BCA Bootstrap UCL	608.6	95% Bootstrap t UCL	1451
95% H-UCL (Log ROS)	469.7		

#### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.774	95% H-UCL (KM -Log)	286.4
KM SD (logged)	0.879	95% Critical H Value (KM-Log)	2.464
KM Standard Error of Mean (logged)	0.228		

#### DL/2 Statistics

##### DL/2 Normal

Mean in Original Scale	261.9
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##### DL/2 Log-Transformed

Mean in Log Scale	4.869
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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

SD in Original Scale	547.3	SD in Log Scale	0.936
95% t UCL (Assumes normality)	473.5	95% H-Stat UCL	348.5

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL 487.7      95% KM (Percentile Bootstrap) UCL N/A

**Warning: One or more Recommended UCL(s) not available!**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## 2,4,6-Trinitrotoluene

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	16
Number of Detects	10	Number of Non-Detects	10
Number of Distinct Detects	10	Number of Distinct Non-Detects	6
Minimum Detect	170	Minimum Non-Detect	99
Maximum Detect	14000000	Maximum Non-Detect	390
Variance Detects	1.951E+13	Percent Non-Detects	50%
Mean Detects	2051044	SD Detects	4417563
Median Detects	185500	CV Detects	2.154
Skewness Detects	2.689	Kurtosis Detects	7.422
Mean of Logged Detects	11.06	SD of Logged Detects	3.872

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.548	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.402	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.28	Detected Data Not Normal at 5% Significance Level

**Detected Data Not Normal at 5% Significance Level**

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### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1025581	Standard Error of Mean	739116
SD	3135803	95% KM (BCA) UCL	2377239
95% KM (t) UCL	2303610	95% KM (Percentile Bootstrap) UCL	2403248
95% KM (z) UCL	2241318	95% KM Bootstrap t UCL	12631538
90% KM Chebyshev UCL	3242929	95% KM Chebyshev UCL	4247312
97.5% KM Chebyshev UCL	5641358	99% KM Chebyshev UCL	8379691

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.312	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.851	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.21	k star (bias corrected MLE)	0.214
Theta hat (MLE)	9751584	Theta star (bias corrected MLE)	9588925
nu hat (MLE)	4.207	nu star (bias corrected)	4.278
MLE Mean (bias corrected)	2051044	MLE Sd (bias corrected)	4434784

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.107	nu hat (KM)	4.279
Approximate Chi Square Value (4.28, $\alpha$ )	0.835	Adjusted Chi Square Value (4.28, $\beta$ )	0.725
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	5256691	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	6051222

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1025522
Maximum	14000000	Median	85.01
SD	3217286	CV	3.137
k hat (MLE)	0.0787	k star (bias corrected MLE)	0.1
Theta hat (MLE)	13023041	Theta star (bias corrected MLE)	10227803
nu hat (MLE)	3.15	nu star (bias corrected)	4.011
MLE Mean (bias corrected)	1025522	MLE Sd (bias corrected)	3238647
		Adjusted Level of Significance ( $\beta$ )	0.038
Approximate Chi Square Value (4.01, $\alpha$ )	0.726	Adjusted Chi Square Value (4.01, $\beta$ )	0.627
95% Gamma Approximate UCL (use when $n \geq 50$ )	5665909	95% Gamma Adjusted UCL (use when $n < 50$ )	6562217

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.95	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.162	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

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### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1025534	Mean in Log Scale	6.095
SD in Original Scale	3217282	SD in Log Scale	5.978
95% t UCL (assumes normality of ROS data)	2269483	95% Percentile Bootstrap UCL	2406862
95% BCA Bootstrap UCL	3538664	95% Bootstrap t UCL	13038696
95% H-UCL (Log ROS)	3.227E+17		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	7.901	95% H-UCL (KM -Log)	1.927E+10
KM SD (logged)	4.095	95% Critical H Value (KM-Log)	7.872
KM Standard Error of Mean (logged)	0.968		

### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1025577	Mean in Log Scale	7.843
SD in Original Scale	3217268	SD in Log Scale	4.253
95% t UCL (Assumes normality)	2269520	95% H-Stat UCL	6.904E+10

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	2303610	95% GROS Adjusted Gamma UCL	6562217
95% Adjusted Gamma KM-UCL	6051222		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## 2-Amino-4,6-dinitrotoluene

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	12
Number of Detects	6	Number of Non-Detects	14
Number of Distinct Detects	6	Number of Distinct Non-Detects	6
Minimum Detect	870	Minimum Non-Detect	99
Maximum Detect	16000	Maximum Non-Detect	390
Variance Detects	49511217	Percent Non-Detects	70%
Mean Detects	6928	SD Detects	7036
Median Detects	4250	CV Detects	1.016
Skewness Detects	0.597	Kurtosis Detects	-2.145
Mean of Logged Detects	8.211	SD of Logged Detects	1.329

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### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.803	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.284	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2148	Standard Error of Mean	1153
SD	4709	95% KM (BCA) UCL	4012
95% KM (t) UCL	4142	95% KM (Percentile Bootstrap) UCL	4074
95% KM (z) UCL	4045	95% KM Bootstrap t UCL	6505
90% KM Chebyshev UCL	5608	95% KM Chebyshev UCL	7175
97.5% KM Chebyshev UCL	9351	99% KM Chebyshev UCL	13624

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.565	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.717	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.299	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.342	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.922	k star (bias corrected MLE)	0.572
Theta hat (MLE)	7515	Theta star (bias corrected MLE)	12111
nu hat (MLE)	11.06	nu star (bias corrected)	6.865
MLE Mean (bias corrected)	6928	MLE Sd (bias corrected)	9160

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.208	nu hat (KM)	8.322
Approximate Chi Square Value (8.32, $\alpha$ )	2.923	Adjusted Chi Square Value (8.32, $\beta$ )	2.675
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	6115	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	6681

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2079
Maximum	16000	Median	0.01
SD	4862	CV	2.339
k hat (MLE)	0.097	k star (bias corrected MLE)	0.116
Theta hat (MLE)	21417	Theta star (bias corrected MLE)	17945
nu hat (MLE)	3.882	nu star (bias corrected)	4.633
MLE Mean (bias corrected)	2079	MLE Sd (bias corrected)	6107
		Adjusted Level of Significance ( $\beta$ )	0.038
Approximate Chi Square Value (4.63, $\alpha$ )	0.987	Adjusted Chi Square Value (4.63, $\beta$ )	0.863
95% Gamma Approximate UCL (use when $n \geq 50$ )	9761	95% Gamma Adjusted UCL (use when $n < 50$ )	11153

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### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.839	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.266	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

**Detected Data appear Lognormal at 5% Significance Level**

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2120	Mean in Log Scale	4.847
SD in Original Scale	4844	SD in Log Scale	2.604
95% t UCL (assumes normality of ROS data)	3993	95% Percentile Bootstrap UCL	3977
95% BCA Bootstrap UCL	4433	95% Bootstrap t UCL	6884
95% H-UCL (Log ROS)	95974		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.68	95% H-UCL (KM -Log)	7185
KM SD (logged)	1.785	95% Critical H Value (KM-Log)	3.921
KM Standard Error of Mean (logged)	0.437		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	2150
SD in Original Scale	4830
95% t UCL (Assumes normality)	4018

#### DL/2 Log-Transformed

Mean in Log Scale	5.647
SD in Log Scale	1.889
95% H-Stat UCL	9993

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	4142	95% KM (Percentile Bootstrap) UCL	4074
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

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### 2-Nitrotoluene

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	6
Number of Detects	1	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	5

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!**

**It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTv).**

**The data set for variable 2-Nitrotoluene was not processed!**

### 4-Amino-2,6-dinitrotoluene

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	13
Number of Detects	7	Number of Non-Detects	12
Number of Distinct Detects	7	Number of Distinct Non-Detects	6
Minimum Detect	710	Minimum Non-Detect	99
Maximum Detect	17000	Maximum Non-Detect	390
Variance Detects	49576033	Percent Non-Detects	63.16%
Mean Detects	7370	SD Detects	7041
Median Detects	4500	CV Detects	0.955
Skewness Detects	0.381	Kurtosis Detects	-2.265
Mean of Logged Detects	8.267	SD of Logged Detects	1.362

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.831	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Normal at 5% Significance Level**

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2778	Standard Error of Mean	1310
SD	5287	95% KM (BCA) UCL	4799
95% KM (t) UCL	5050	95% KM (Percentile Bootstrap) UCL	4909
95% KM (z) UCL	4933	95% KM Bootstrap t UCL	5607
90% KM Chebyshev UCL	6708	95% KM Chebyshev UCL	8489
97.5% KM Chebyshev UCL	10960	99% KM Chebyshev UCL	15814

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.535	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.73	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.254	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.321	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

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### Gamma Statistics on Detected Data Only

k hat (MLE)	0.914	k star (bias corrected MLE)	0.618
Theta hat (MLE)	8060	Theta star (bias corrected MLE)	11931
nu hat (MLE)	12.8	nu star (bias corrected)	8.648
MLE Mean (bias corrected)	7370	MLE Sd (bias corrected)	9377

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.276	nu hat (KM)	10.49
Approximate Chi Square Value (10.49, $\alpha$ )	4.249	Adjusted Chi Square Value (10.49, $\beta$ )	3.907
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	6857	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	7457

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2715
Maximum	17000	Median	0.01
SD	5465	CV	2.013
k hat (MLE)	0.104	k star (bias corrected MLE)	0.123
Theta hat (MLE)	26106	Theta star (bias corrected MLE)	22134
nu hat (MLE)	3.952	nu star (bias corrected)	4.662
MLE Mean (bias corrected)	2715	MLE Sd (bias corrected)	7752
		Adjusted Level of Significance ( $\beta$ )	0.0369
Approximate Chi Square Value (4.66, $\alpha$ )	0.999	Adjusted Chi Square Value (4.66, $\beta$ )	0.862
95% Gamma Approximate UCL (use when $n \geq 50$ )	12668	95% Gamma Adjusted UCL (use when $n < 50$ )	14677

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.862	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.241	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2765	Mean in Log Scale	5.521
SD in Original Scale	5439	SD in Log Scale	2.439
95% t UCL (assumes normality of ROS data)	4929	95% Percentile Bootstrap UCL	4959
95% BCA Bootstrap UCL	5475	95% Bootstrap t UCL	5869
95% H-UCL (Log ROS)	88854		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.948	95% H-UCL (KM -Log)	16089
KM SD (logged)	1.93	95% Critical H Value (KM-Log)	4.126
KM Standard Error of Mean (logged)	0.478		

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DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2783	Mean in Log Scale	5.943
SD in Original Scale	5430	SD in Log Scale	2.015
95% t UCL (Assumes normality)	4943	95% H-Stat UCL	22174
DL/2 is not a recommended method, provided for comparisons and historical reasons			

**Nonparametric Distribution Free UCL Statistics**  
Detected Data appear Normal Distributed at 5% Significance Level

**Suggested UCL to Use**  
95% KM (t) UCL 5050      95% KM (Percentile Bootstrap) UCL 4909

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## Aluminum

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	2700	Mean	7857
Maximum	25000	Median	6850
SD	4891	Std. Error of Mean	1094
Coefficient of Variation	0.622	Skewness	2.376

Normal GOF Test		Shapiro Wilk GOF Test	
Shapiro Wilk Test Statistic	0.773	Data Not Normal at 5% Significance Level	
5% Shapiro Wilk Critical Value	0.905	Lilliefors GOF Test	
Lilliefors Test Statistic	0.171	Data appear Normal at 5% Significance Level	
5% Lilliefors Critical Value	0.198		

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
95% Normal UCL		95% Adjusted-CLT UCL (Chen-1995)	10277
95% Student's-t UCL	9748	95% Modified-t UCL (Johnson-1978)	9845

Gamma GOF Test		Anderson-Darling Gamma GOF Test	
A-D Test Statistic	0.37	Detected data appear Gamma Distributed at 5% Significance Level	
5% A-D Critical Value	0.746	Kolmogrov-Smirnov Gamma GOF Test	
K-S Test Statistic	0.113	Detected data appear Gamma Distributed at 5% Significance Level	
5% K-S Critical Value	0.195		

Detected data appear Gamma Distributed at 5% Significance Level

## Gamma Statistics

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k hat (MLE)	3.765	k star (bias corrected MLE)	3.234
Theta hat (MLE)	2087	Theta star (bias corrected MLE)	2430
nu hat (MLE)	150.6	nu star (bias corrected)	129.3
MLE Mean (bias corrected)	7857	MLE Sd (bias corrected)	4369
		Approximate Chi Square Value (0.05)	104.1
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	102.3

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$ )	9765	95% Adjusted Gamma UCL (use when $n < 50$ )	9936
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0968	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	7.901	Mean of logged Data	8.831
Maximum of Logged Data	10.13	SD of logged Data	0.521

### Assuming Lognormal Distribution

95% H-UCL	9996	90% Chebyshev (MVUE) UCL	10599
95% Chebyshev (MVUE) UCL	11878	97.5% Chebyshev (MVUE) UCL	13654
99% Chebyshev (MVUE) UCL	17141		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	9656	95% Jackknife UCL	9748
95% Standard Bootstrap UCL	9572	95% Bootstrap-t UCL	10798
95% Hall's Bootstrap UCL	18138	95% Percentile Bootstrap UCL	9792
95% BCA Bootstrap UCL	10489		
90% Chebyshev(Mean, Sd) UCL	11138	95% Chebyshev(Mean, Sd) UCL	12624
97.5% Chebyshev(Mean, Sd) UCL	14687	99% Chebyshev(Mean, Sd) UCL	18739

### Suggested UCL to Use

95% Student's-t UCL 9748

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

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### Arsenic

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	1.1	Mean	3.865
Maximum	11.8	Median	3.2
SD	2.697	Std. Error of Mean	0.603
Coefficient of Variation	0.698	Skewness	1.511
Normal GOF Test			
Shapiro Wilk Test Statistic	0.859	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.189	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4.908	95% Adjusted-CLT UCL (Chen-1995)	5.075
		95% Modified-t UCL (Johnson-1978)	4.942
Gamma GOF Test			
A-D Test Statistic	0.317	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.123	Kolmogrov-Smimoff Gamma GOF Test	
5% K-S Critical Value	0.196	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.526	k star (bias corrected MLE)	2.181
Theta hat (MLE)	1.53	Theta star (bias corrected MLE)	1.773
nu hat (MLE)	101	nu star (bias corrected)	87.22
MLE Mean (bias corrected)	3.865	MLE Sd (bias corrected)	2.617
		Approximate Chi Square Value (0.05)	66.69
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	65.27
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	5.055	95% Adjusted Gamma UCL (use when n<50)	5.165
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.968	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.12	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			

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Minimum of Logged Data	0.0953	Mean of logged Data	1.141
Maximum of Logged Data	2.468	SD of logged Data	0.667

### Assuming Lognormal Distribution

95% H-UCL	5.471	90% Chebyshev (MVUE) UCL	5.69
95% Chebyshev (MVUE) UCL	6.52	97.5% Chebyshev (MVUE) UCL	7.671
99% Chebyshev (MVUE) UCL	9.933		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	4.857	95% Jackknife UCL	4.908
95% Standard Bootstrap UCL	4.822	95% Bootstrap-t UCL	5.3
95% Hall's Bootstrap UCL	5.538	95% Percentile Bootstrap UCL	4.91
95% BCA Bootstrap UCL	5.03		
90% Chebyshev(Mean, Sd) UCL	5.674	95% Chebyshev(Mean, Sd) UCL	6.494
97.5% Chebyshev(Mean, Sd) UCL	7.632	99% Chebyshev(Mean, Sd) UCL	9.866

### Suggested UCL to Use

95% Student's-t UCL 4.908

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Cobalt

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	0.57	Mean	2.054
Maximum	3.6	Median	2.05
SD	0.802	Std. Error of Mean	0.179
Coefficient of Variation	0.391	Skewness	0.117

### Normal GOF Test

Shapiro Wilk Test Statistic	0.982
5% Shapiro Wilk Critical Value	0.905
Lilliefors Test Statistic	0.0978
5% Lilliefors Critical Value	0.198

### Shapiro Wilk GOF Test

Data appear Normal at 5% Significance Level

### Lilliefors GOF Test

Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 2.364

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 2.353

95% Modified-t UCL (Johnson-1978) 2.364

### Gamma GOF Test

A-D Test Statistic 0.268

5% A-D Critical Value 0.745

K-S Test Statistic 0.12

5% K-S Critical Value 0.194

### Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

### Kolmogrov-Smirnoff Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

### Gamma Statistics

k hat (MLE) 5.903

Theta hat (MLE) 0.348

nu hat (MLE) 236.1

MLE Mean (bias corrected) 2.054

Adjusted Level of Significance 0.038

k star (bias corrected MLE) 5.051

Theta star (bias corrected MLE) 0.407

nu star (bias corrected) 202.1

MLE Sd (bias corrected) 0.914

Approximate Chi Square Value (0.05) 170.2

Adjusted Chi Square Value 167.9

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when  $n \geq 50$ ) 2.438

95% Adjusted Gamma UCL (use when  $n < 50$ ) 2.472

### Lognormal GOF Test

Shapiro Wilk Test Statistic 0.939

5% Shapiro Wilk Critical Value 0.905

Lilliefors Test Statistic 0.134

5% Lilliefors Critical Value 0.198

### Shapiro Wilk Lognormal GOF Test

Data appear Lognormal at 5% Significance Level

### Lilliefors Lognormal GOF Test

Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data -0.562

Maximum of Logged Data 1.281

Mean of logged Data 0.632

SD of logged Data 0.456

### Assuming Lognormal Distribution

95% H-UCL 2.57

95% Chebyshev (MVUE) UCL 3.03

99% Chebyshev (MVUE) UCL 4.252

90% Chebyshev (MVUE) UCL 2.733

97.5% Chebyshev (MVUE) UCL 3.442

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

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Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Nonparametric Distribution Free UCLs

95% CLT UCL	2.348	95% Jackknife UCL	2.364
95% Standard Bootstrap UCL	2.344	95% Bootstrap-t UCL	2.37
95% Hall's Bootstrap UCL	2.364	95% Percentile Bootstrap UCL	2.355
95% BCA Bootstrap UCL	2.325		
90% Chebyshev(Mean, Sd) UCL	2.591	95% Chebyshev(Mean, Sd) UCL	2.835
97.5% Chebyshev(Mean, Sd) UCL	3.173	99% Chebyshev(Mean, Sd) UCL	3.838

### Suggested UCL to Use

95% Student's-t UCL 2.364

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Iron

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	3800	Mean	11398
Maximum	38000	Median	8650
SD	10046	Std. Error of Mean	2246
Coefficient of Variation	0.881	Skewness	1.972

### Normal GOF Test

Shapiro Wilk Test Statistic	0.715
5% Shapiro Wilk Critical Value	0.905
Lilliefors Test Statistic	0.248
5% Lilliefors Critical Value	0.198

### Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

### Lilliefors GOF Test

Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 15282

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	16151
95% Modified-t UCL (Johnson-1978)	15447

### Gamma GOF Test

A-D Test Statistic	0.96
5% A-D Critical Value	0.752
K-S Test Statistic	0.182
5% K-S Critical Value	0.196

### Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

### Kolmogorov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

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### Gamma Statistics

k hat (MLE)	2.019	k star (bias corrected MLE)	1.75
Theta hat (MLE)	5644	Theta star (bias corrected MLE)	6514
nu hat (MLE)	80.77	nu star (bias corrected)	69.99
MLE Mean (bias corrected)	11398	MLE Sd (bias corrected)	8617
		Approximate Chi Square Value (0.05)	51.73
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	50.49

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when  $n \geq 50$ ) 15421      95% Adjusted Gamma UCL (use when  $n < 50$ ) 15800

### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.909	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.132	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	8.243	Mean of logged Data	9.074
Maximum of Logged Data	10.55	SD of logged Data	0.705

### Assuming Lognormal Distribution

95% H-UCL	16060	90% Chebyshev (MVUE) UCL	16571
95% Chebyshev (MVUE) UCL	19089	97.5% Chebyshev (MVUE) UCL	22583
99% Chebyshev (MVUE) UCL	29447		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	15093	95% Jackknife UCL	15282
95% Standard Bootstrap UCL	15106	95% Bootstrap-t UCL	19232
95% Hall's Bootstrap UCL	20230	95% Percentile Bootstrap UCL	15119
95% BCA Bootstrap UCL	16194		
90% Chebyshev(Mean, Sd) UCL	18137	95% Chebyshev(Mean, Sd) UCL	21189
97.5% Chebyshev(Mean, Sd) UCL	25426	99% Chebyshev(Mean, Sd) UCL	33748

### Suggested UCL to Use

95% Adjusted Gamma UCL 15800

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Appendix I

ProUCL Output - Surface Soil

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Lead

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	9.9	Mean	122.6
Maximum	1100	Median	26
SD	262.8	Std. Error of Mean	58.76
Coefficient of Variation	2.143	Skewness	3.27
Normal GOF Test			
Shapiro Wilk Test Statistic	0.474	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.369	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.198	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	224.2	95% Adjusted-CLT UCL (Chen-1995)	265.2
		95% Modified-t UCL (Johnson-1978)	231.4
Gamma GOF Test			
A-D Test Statistic	2.039	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.797	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.204	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.558	k star (bias corrected MLE)	0.508
Theta hat (MLE)	219.8	Theta star (bias corrected MLE)	241.6
nu hat (MLE)	22.32	nu star (bias corrected)	20.3
MLE Mean (bias corrected)	122.6	MLE Sd (bias corrected)	172.1
		Approximate Chi Square Value (0.05)	11.08
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	10.54
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	224.8	95% Adjusted Gamma UCL (use when n<50)	236.3
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.872	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.905	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.187	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.198	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			

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### Lognormal Statistics

Minimum of Logged Data	2.293	Mean of logged Data	3.69
Maximum of Logged Data	7.003	SD of logged Data	1.325

### Assuming Lognormal Distribution

95% H-UCL	250.1	90% Chebyshev (MVUE) UCL	182.7
95% Chebyshev (MVUE) UCL	225	97.5% Chebyshev (MVUE) UCL	283.6
99% Chebyshev (MVUE) UCL	398.8		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	219.3	95% Jackknife UCL	224.2
95% Standard Bootstrap UCL	217.6	95% Bootstrap-t UCL	640.3
95% Hall's Bootstrap UCL	634.1	95% Percentile Bootstrap UCL	227.2
95% BCA Bootstrap UCL	290		
90% Chebyshev(Mean, Sd) UCL	298.9	95% Chebyshev(Mean, Sd) UCL	378.8
97.5% Chebyshev(Mean, Sd) UCL	489.6	99% Chebyshev(Mean, Sd) UCL	707.3

### Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 378.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Thallium

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	18
Number of Detects	14	Number of Non-Detects	6
Number of Distinct Detects	13	Number of Distinct Non-Detects	6
Minimum Detect	0.058	Minimum Non-Detect	0.09
Maximum Detect	0.18	Maximum Non-Detect	5.7
Variance Detects	9.7049E-4	Percent Non-Detects	30%
Mean Detects	0.0952	SD Detects	0.0312
Median Detects	0.0895	CV Detects	0.327
Skewness Detects	1.779	Kurtosis Detects	3.821
Mean of Logged Detects	-2.393	SD of Logged Detects	0.288

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.817	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.296	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.237	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

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### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.094	Standard Error of Mean	0.00795
SD	0.0295	95% KM (BCA) UCL	0.108
95% KM (t) UCL	0.108	95% KM (Percentile Bootstrap) UCL	0.108
95% KM (z) UCL	0.107	95% KM Bootstrap t UCL	0.118
90% KM Chebyshev UCL	0.118	95% KM Chebyshev UCL	0.129
97.5% KM Chebyshev UCL	0.144	99% KM Chebyshev UCL	0.173

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.682	Anderson-Darling GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.229	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

### Gamma Statistics on Detected Data Only

k hat (MLE)	12.23	k star (bias corrected MLE)	9.66
Theta hat (MLE)	0.00778	Theta star (bias corrected MLE)	0.00986
nu hat (MLE)	342.5	nu star (bias corrected)	270.5
MLE Mean (bias corrected)	0.0952	MLE Sd (bias corrected)	0.0306

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	10.13	nu hat (KM)	405.2
Approximate Chi Square Value (405.20, $\alpha$ )	359.5	Adjusted Chi Square Value (405.20, $\beta$ )	356.1
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	0.106	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	0.107

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.058	Mean	0.0932
Maximum	0.18	Median	0.0913
SD	0.0262	CV	0.282
k hat (MLE)	16.54	k star (bias corrected MLE)	14.1
Theta hat (MLE)	0.00563	Theta star (bias corrected MLE)	0.00661
nu hat (MLE)	661.7	nu star (bias corrected)	563.8
MLE Mean (bias corrected)	0.0932	MLE Sd (bias corrected)	0.0248
		Adjusted Level of Significance ( $\beta$ )	0.038
Approximate Chi Square Value (563.81, $\alpha$ )	509.7	Adjusted Chi Square Value (563.81, $\beta$ )	505.7
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.103	95% Gamma Adjusted UCL (use when $n < 50$ )	0.104

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.919	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.234	Lilliefors GOF Test
5% Lilliefors Critical Value	0.237	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

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### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0929	Mean in Log Scale	-2.407
SD in Original Scale	0.0262	SD in Log Scale	0.242
95% t UCL (assumes normality of ROS data)	0.103	95% Percentile Bootstrap UCL	0.103
95% BCA Bootstrap UCL	0.106	95% Bootstrap t UCL	0.111
95% H-UCL (Log ROS)	0.103		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.406	95% H-UCL (KM -Log)	0.105
KM SD (logged)	0.275	95% Critical H Value (KM-Log)	1.834
KM Standard Error of Mean (logged)	0.0746		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	0.446
SD in Original Scale	0.73
95% t UCL (Assumes normality)	0.729

#### DL/2 Log-Transformed

Mean in Log Scale	-1.752
SD in Log Scale	1.276
95% H-Stat UCL	0.957

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (Percentile Bootstrap) UCL	0.108	95% GROS Adjusted Gamma UCL	0.104
95% Adjusted Gamma KM-UCL	0.107		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## Vanadium

### General Statistics

Total Number of Observations	20	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	7.6	Mean	18.95
Maximum	50	Median	18.05
SD	9.636	Std. Error of Mean	2.155
Coefficient of Variation	0.509	Skewness	1.713

### Normal GOF Test

Shapiro Wilk Test Statistic	0.848
5% Shapiro Wilk Critical Value	0.905
Lilliefors Test Statistic	0.152
5% Lilliefors Critical Value	0.198

### Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

### Lilliefors GOF Test

Data appear Normal at 5% Significance Level

**Data appear Approximate Normal at 5% Significance Level**

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### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 22.67

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 23.37

95% Modified-t UCL (Johnson-1978) 22.81

### Gamma GOF Test

A-D Test Statistic 0.36

5% A-D Critical Value 0.745

K-S Test Statistic 0.13

5% K-S Critical Value 0.195

### Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

### Kolmogrov-Smirnoff Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

### Gamma Statistics

k hat (MLE) 4.809

Theta hat (MLE) 3.939

nu hat (MLE) 192.4

MLE Mean (bias corrected) 18.95

Adjusted Level of Significance 0.038

k star (bias corrected MLE) 4.121

Theta star (bias corrected MLE) 4.597

nu star (bias corrected) 164.8

MLE Sd (bias corrected) 9.332

Approximate Chi Square Value (0.05) 136.2

Adjusted Chi Square Value 134.1

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when  $n \geq 50$ ) 22.94

95% Adjusted Gamma UCL (use when  $n < 50$ ) 23.29

### Lognormal GOF Test

Shapiro Wilk Test Statistic 0.962

5% Shapiro Wilk Critical Value 0.905

Lilliefors Test Statistic 0.12

5% Lilliefors Critical Value 0.198

### Shapiro Wilk Lognormal GOF Test

Data appear Lognormal at 5% Significance Level

### Lilliefors Lognormal GOF Test

Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data 2.028

Maximum of Logged Data 3.912

Mean of logged Data 2.834

SD of logged Data 0.472

### Assuming Lognormal Distribution

95% H-UCL 23.59

95% Chebyshev (MVUE) UCL 27.87

99% Chebyshev (MVUE) UCL 39.38

90% Chebyshev (MVUE) UCL 25.07

97.5% Chebyshev (MVUE) UCL 31.75

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL 22.49

95% Standard Bootstrap UCL 22.47

95% Hall's Bootstrap UCL 26.92

95% BCA Bootstrap UCL 23.27

90% Chebyshev(Mean, Sd) UCL 25.41

97.5% Chebyshev(Mean, Sd) UCL 32.4

95% Jackknife UCL 22.67

95% Bootstrap-t UCL 24.3

95% Percentile Bootstrap UCL 22.61

95% Chebyshev(Mean, Sd) UCL 28.34

99% Chebyshev(Mean, Sd) UCL 40.38

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### Suggested UCL to Use

95% Student's-t UCL    22.67

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Appendix I

ProUCL Output - Surface and Subsurface Soil

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### UCL Statistics for Data Sets with Non-Detects

#### User Selected Options

Date/Time of Computation 5/7/2014 11:29:15 AM  
From File SSSB\_proUCL\_Cax AOC6\_input\_revision.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

#### 2,4-Dinitrotoluene

##### General Statistics

Total Number of Observations	40	Number of Distinct Observations	22
Number of Detects	9	Number of Non-Detects	31
Number of Distinct Detects	9	Number of Distinct Non-Detects	13
Minimum Detect	140	Minimum Non-Detect	99
Maximum Detect	12000	Maximum Non-Detect	460
Variance Detects	15929928	Percent Non-Detects	77.5%
Mean Detects	2634	SD Detects	3991
Median Detects	780	CV Detects	1.515
Skewness Detects	2.06	Kurtosis Detects	3.87
Mean of Logged Detects	6.96	SD of Logged Detects	1.43

##### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.672	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.37	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.295	Detected Data Not Normal at 5% Significance Level

**Detected Data Not Normal at 5% Significance Level**

##### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	686.9	Standard Error of Mean	347.5
SD	2071	95% KM (BCA) UCL	1411
95% KM (t) UCL	1272	95% KM (Percentile Bootstrap) UCL	1281
95% KM (z) UCL	1258	95% KM Bootstrap t UCL	3560
90% KM Chebyshev UCL	1729	95% KM Chebyshev UCL	2202
97.5% KM Chebyshev UCL	2857	99% KM Chebyshev UCL	4144

##### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.528	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.241	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.291	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

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ProUCL Output - Surface and Subsurface Soil

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.664	k star (bias corrected MLE)	0.517
Theta hat (MLE)	3967	Theta star (bias corrected MLE)	5097
nu hat (MLE)	11.95	nu star (bias corrected)	9.303
MLE Mean (bias corrected)	2634	MLE Sd (bias corrected)	3665

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.11	nu hat (KM)	8.802
Approximate Chi Square Value (8.80, $\alpha$ )	3.208	Adjusted Chi Square Value (8.80, $\beta$ )	3.082
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	1885	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	1962

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	592.8
Maximum	12000	Median	0.01
SD	2123	CV	3.582
k hat (MLE)	0.0972	k star (bias corrected MLE)	0.107
Theta hat (MLE)	6100	Theta star (bias corrected MLE)	5563
nu hat (MLE)	7.774	nu star (bias corrected)	8.524
MLE Mean (bias corrected)	592.8	MLE Sd (bias corrected)	1816
		Adjusted Level of Significance ( $\beta$ )	0.044
Approximate Chi Square Value (8.52, $\alpha$ )	3.042	Adjusted Chi Square Value (8.52, $\beta$ )	2.92
95% Gamma Approximate UCL (use when $n \geq 50$ )	1661	95% Gamma Adjusted UCL (use when $n < 50$ )	1730

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.964	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.147	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.295	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	620.5	Mean in Log Scale	3.811
SD in Original Scale	2116	SD in Log Scale	2.165
95% t UCL (assumes normality of ROS data)	1184	95% Percentile Bootstrap UCL	1217
95% BCA Bootstrap UCL	1493	95% Bootstrap t UCL	4006
95% H-UCL (Log ROS)	1897		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.267	95% H-UCL (KM -Log)	582.2
KM SD (logged)	1.128	95% Critical H Value (KM-Log)	2.561
KM Standard Error of Mean (logged)	0.214		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	698.9
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#### DL/2 Log-Transformed

Mean in Log Scale	5.342
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SD in Original Scale	2094	SD in Log Scale	1.129
95% t UCL (Assumes normality)	1257	95% H-Stat UCL	628.4

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	1272	95% GROS Adjusted Gamma UCL	1730
95% Adjusted Gamma KM-UCL	1962		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## 1,3-Dinitrobenzene

### General Statistics

Total Number of Observations	40	Number of Distinct Observations	17
Number of Detects	8	Number of Non-Detects	32
Number of Distinct Detects	7	Number of Distinct Non-Detects	10
Minimum Detect	28	Minimum Non-Detect	99
Maximum Detect	2500	Maximum Non-Detect	390
Variance Detects	800769	Percent Non-Detects	80%
Mean Detects	877.8	SD Detects	894.9
Median Detects	510	CV Detects	1.019
Skewness Detects	0.894	Kurtosis Detects	-0.352
Mean of Logged Detects	6.026	SD of Logged Detects	1.563

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.872	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.244	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.313	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Normal at 5% Significance Level**

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### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	220.7	Standard Error of Mean	86.1
SD	498.8	95% KM (BCA) UCL	364
95% KM (t) UCL	365.8	95% KM (Percentile Bootstrap) UCL	375.5
95% KM (z) UCL	362.3	95% KM Bootstrap t UCL	464.2
90% KM Chebyshev UCL	479	95% KM Chebyshev UCL	596
97.5% KM Chebyshev UCL	758.4	99% KM Chebyshev UCL	1077

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.258	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.304	Detected data appear Gamma Distributed at 5% Significance Level
		<b>Detected data appear Gamma Distributed at 5% Significance Level</b>

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.791	k star (bias corrected MLE)	0.578
Theta hat (MLE)	1109	Theta star (bias corrected MLE)	1519
nu hat (MLE)	12.66	nu star (bias corrected)	9.247
MLE Mean (bias corrected)	877.8	MLE Sd (bias corrected)	1155

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.196	nu hat (KM)	15.66
Approximate Chi Square Value (15.66, $\alpha$ )	7.724	Adjusted Chi Square Value (15.66, $\beta$ )	7.515
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	447.5	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	459.9

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	204.6
Maximum	2500	Median	0.01
SD	517.2	CV	2.528
k hat (MLE)	0.124	k star (bias corrected MLE)	0.131
Theta hat (MLE)	1652	Theta star (bias corrected MLE)	1559
nu hat (MLE)	9.907	nu star (bias corrected)	10.5
MLE Mean (bias corrected)	204.6	MLE Sd (bias corrected)	564.9
		Adjusted Level of Significance ( $\beta$ )	0.044
Approximate Chi Square Value (10.50, $\alpha$ )	4.255	Adjusted Chi Square Value (10.50, $\beta$ )	4.106
95% Gamma Approximate UCL (use when $n \geq 50$ )	504.8	95% Gamma Adjusted UCL (use when $n < 50$ )	523.1

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.931	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level
		<b>Detected Data appear Lognormal at 5% Significance Level</b>

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### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	227.1	Mean in Log Scale	4.191
SD in Original Scale	505.3	SD in Log Scale	1.456
95% t UCL (assumes normality of ROS data)	361.7	95% Percentile Bootstrap UCL	367.2
95% BCA Bootstrap UCL	418.5	95% Bootstrap t UCL	495.3
95% H-UCL (Log ROS)	382.6		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	4.313	95% H-UCL (KM -Log)	248.8
KM SD (logged)	1.186	95% Critical H Value (KM-Log)	2.633
KM Standard Error of Mean (logged)	0.396		

### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	256	Mean in Log Scale	4.842
SD in Original Scale	493.7	SD in Log Scale	0.958
95% t UCL (Assumes normality)	387.6	95% H-Stat UCL	288

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	365.8	95% KM (Percentile Bootstrap) UCL	375.5
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## 2,4,6-Trinitrotoluene

### General Statistics

Total Number of Observations	40	Number of Distinct Observations	27
Number of Detects	18	Number of Non-Detects	22
Number of Distinct Detects	18	Number of Distinct Non-Detects	9
Minimum Detect	170	Minimum Non-Detect	99
Maximum Detect	14000000	Maximum Non-Detect	390
Variance Detects	1.464E+13	Percent Non-Detects	55%
Mean Detects	1875002	SD Detects	3826243
Median Detects	200000	CV Detects	2.041
Skewness Detects	2.531	Kurtosis Detects	6.095
Mean of Logged Detects	11.26	SD of Logged Detects	3.568

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### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.566	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.377	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.209	Detected Data Not Normal at 5% Significance Level

**Detected Data Not Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	843810	Standard Error of Mean	433280
SD	2663095	95% KM (BCA) UCL	1657926
95% KM (t) UCL	1573833	95% KM (Percentile Bootstrap) UCL	1573116
95% KM (z) UCL	1556492	95% KM Bootstrap t UCL	2921907
90% KM Chebyshev UCL	2143650	95% KM Chebyshev UCL	2732434
97.5% KM Chebyshev UCL	3549642	99% KM Chebyshev UCL	5154891

### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.499	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.877	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.17	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.225	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.226	k star (bias corrected MLE)	0.226
Theta hat (MLE)	8279230	Theta star (bias corrected MLE)	8305197
nu hat (MLE)	8.153	nu star (bias corrected)	8.127
MLE Mean (bias corrected)	1875002	MLE Sd (bias corrected)	3946171

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.1	nu hat (KM)	8.032
Approximate Chi Square Value (8.03, $\alpha$ )	2.753	Adjusted Chi Square Value (8.03, $\beta$ )	2.639
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	2461420	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	2568494

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	843751
Maximum	14000000	Median	0.01
SD	2697040	CV	3.196
k hat (MLE)	0.0756	k star (bias corrected MLE)	0.0866
Theta hat (MLE)	11167959	Theta star (bias corrected MLE)	9748555
nu hat (MLE)	6.044	nu star (bias corrected)	6.924
MLE Mean (bias corrected)	843751	MLE Sd (bias corrected)	2867988
		Adjusted Level of Significance ( $\beta$ )	0.044
Approximate Chi Square Value (6.92, $\alpha$ )	2.129	Adjusted Chi Square Value (6.92, $\beta$ )	2.031
95% Gamma Approximate UCL (use when $n \geq 50$ )	2744131	95% Gamma Adjusted UCL (use when $n < 50$ )	2876703

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### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.935	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.154	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.209	Detected Data appear Lognormal at 5% Significance Level

**Detected Data appear Lognormal at 5% Significance Level**

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	843774	Mean in Log Scale	5.935
SD in Original Scale	2697033	SD in Log Scale	5.75
95% t UCL (assumes normality of ROS data)	1562270	95% Percentile Bootstrap UCL	1650706
95% BCA Bootstrap UCL	1892594	95% Bootstrap t UCL	3123128
95% H-UCL (Log ROS)	4.887E+13		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	7.632	95% H-UCL (KM -Log)	6.069E+8
KM SD (logged)	4.023	95% Critical H Value (KM-Log)	6.982
KM Standard Error of Mean (logged)	0.656		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	843808
SD in Original Scale	2697022
95% t UCL (Assumes normality)	1562300

#### DL/2 Log-Transformed

Mean in Log Scale	7.579
SD in Log Scale	4.121
95% H-Stat UCL	1.065E+9

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	1573833	95% GROS Adjusted Gamma UCL	2876703
95% Adjusted Gamma KM-UCL	2568494		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

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### 2-Amino-4,6-dinitrotoluene

#### General Statistics

Total Number of Observations	40	Number of Distinct Observations	21
Number of Detects	13	Number of Non-Detects	27
Number of Distinct Detects	12	Number of Distinct Non-Detects	9
Minimum Detect	610	Minimum Non-Detect	99
Maximum Detect	16000	Maximum Non-Detect	390
Variance Detects	38446940	Percent Non-Detects	67.5%
Mean Detects	6587	SD Detects	6201
Median Detects	4400	CV Detects	0.941
Skewness Detects	0.61	Kurtosis Detects	-1.484
Mean of Logged Detects	8.193	SD of Logged Detects	1.263

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.816	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.192	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.246	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2208	Standard Error of Mean	750
SD	4557	95% KM (BCA) UCL	3386
95% KM (t) UCL	3471	95% KM (Percentile Bootstrap) UCL	3463
95% KM (z) UCL	3441	95% KM Bootstrap t UCL	4046
90% KM Chebyshev UCL	4458	95% KM Chebyshev UCL	5477
97.5% KM Chebyshev UCL	6891	99% KM Chebyshev UCL	9670

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.595	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.759	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	<b>Kolmogrov-Smirnov GOF</b>
5% K-S Critical Value	0.243	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

#### Gamma Statistics on Detected Data Only

k hat (MLE)	0.967	k star (bias corrected MLE)	0.795
Theta hat (MLE)	6815	Theta star (bias corrected MLE)	8287
nu hat (MLE)	25.13	nu star (bias corrected)	20.67
MLE Mean (bias corrected)	6587	MLE Sd (bias corrected)	7388

#### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.235	nu hat (KM)	18.77
Approximate Chi Square Value (18.77, $\alpha$ )	9.951	Adjusted Chi Square Value (18.77, $\beta$ )	9.71
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	4164	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	4268

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### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2141
Maximum	16000	Median	0.01
SD	4647	CV	2.171
k hat (MLE)	0.1	k star (bias corrected MLE)	0.109
Theta hat (MLE)	21392	Theta star (bias corrected MLE)	19598
nu hat (MLE)	8.006	nu star (bias corrected)	8.739
MLE Mean (bias corrected)	2141	MLE Sd (bias corrected)	6477
		Adjusted Level of Significance ( $\beta$ )	0.044
Approximate Chi Square Value (8.74, $\alpha$ )	3.17	Adjusted Chi Square Value (8.74, $\beta$ )	3.045
95% Gamma Approximate UCL (use when $n \geq 50$ )	5902	95% Gamma Adjusted UCL (use when $n < 50$ )	6144

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.884	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.246	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2218	Mean in Log Scale	5.471
SD in Original Scale	4612	SD in Log Scale	2.268
95% t UCL (assumes normality of ROS data)	3446	95% Percentile Bootstrap UCL	3438
95% BCA Bootstrap UCL	3742	95% Bootstrap t UCL	4003
95% H-UCL (Log ROS)	14204		

### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.765	95% H-UCL (KM -Log)	4666
KM SD (logged)	1.822	95% Critical H Value (KM-Log)	3.51
KM Standard Error of Mean (logged)	0.3		

### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2207	Mean in Log Scale	5.709
SD in Original Scale	4616	SD in Log Scale	1.911
95% t UCL (Assumes normality)	3437	95% H-Stat UCL	5716

DL/2 is not a recommended method, provided for comparisons and historical reasons

### Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

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### Suggested UCL to Use

95% KM (t) UCL 3471

95% KM (Percentile Bootstrap) UCL 3463

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

### 2-Nitrotoluene

#### General Statistics

Total Number of Observations	39	Number of Distinct Observations	11
Number of Detects	1	Number of Non-Detects	38
Number of Distinct Detects	1	Number of Distinct Non-Detects	10

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!**

**It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).**

**The data set for variable 2-Nitrotoluene was not processed!**

### 4-Amino-2,6-dinitrotoluene

#### General Statistics

Total Number of Observations	39	Number of Distinct Observations	22
Number of Detects	13	Number of Non-Detects	26
Number of Distinct Detects	13	Number of Distinct Non-Detects	9
Minimum Detect	340	Minimum Non-Detect	99
Maximum Detect	30000	Maximum Non-Detect	390
Variance Detects	76666400	Percent Non-Detects	66.67%
Mean Detects	8210	SD Detects	8756
Median Detects	4500	CV Detects	1.066
Skewness Detects	1.371	Kurtosis Detects	1.88
Mean of Logged Detects	8.306	SD of Logged Detects	1.397

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.839	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.203	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.246	Detected Data appear Normal at 5% Significance Level

**Detected Data appear Approximate Normal at 5% Significance Level**

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	2803	Standard Error of Mean	1030
SD	6181	95% KM (BCA) UCL	4522
95% KM (t) UCL	4540	95% KM (Percentile Bootstrap) UCL	4568
95% KM (z) UCL	4497	95% KM Bootstrap t UCL	5454
90% KM Chebyshev UCL	5894	95% KM Chebyshev UCL	7293
97.5% KM Chebyshev UCL	9237	99% KM Chebyshev UCL	13053

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### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.305	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.766	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.245	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

k hat (MLE)	0.835	k star (bias corrected MLE)	0.693
Theta hat (MLE)	9836	Theta star (bias corrected MLE)	11841
nu hat (MLE)	21.7	nu star (bias corrected)	18.03
MLE Mean (bias corrected)	8210	MLE Sd (bias corrected)	9860

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.206	nu hat (KM)	16.04
Approximate Chi Square Value (16.04, $\alpha$ )	7.989	Adjusted Chi Square Value (16.04, $\beta$ )	7.765
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	5627	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	5790

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2737
Maximum	30000	Median	0.01
SD	6292	CV	2.299
k hat (MLE)	0.099	k star (bias corrected MLE)	0.108
Theta hat (MLE)	27650	Theta star (bias corrected MLE)	25233
nu hat (MLE)	7.72	nu star (bias corrected)	8.46
MLE Mean (bias corrected)	2737	MLE Sd (bias corrected)	8310
		Adjusted Level of Significance ( $\beta$ )	0.0437
Approximate Chi Square Value (8.46, $\alpha$ )	3.004	Adjusted Chi Square Value (8.46, $\beta$ )	2.877
95% Gamma Approximate UCL (use when $n \geq 50$ )	7707	95% Gamma Adjusted UCL (use when $n < 50$ )	8048

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.951	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.246	Detected Data appear Lognormal at 5% Significance Level

**Detected Data appear Lognormal at 5% Significance Level**

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2797	Mean in Log Scale	5.334
SD in Original Scale	6265	SD in Log Scale	2.509
95% t UCL (assumes normality of ROS data)	4489	95% Percentile Bootstrap UCL	4612
95% BCA Bootstrap UCL	5111	95% Bootstrap t UCL	5528
95% H-UCL (Log ROS)	30532		

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### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	5.833	95% H-UCL (KM -Log)	6567
KM SD (logged)	1.913	95% Critical H Value (KM-Log)	3.631
KM Standard Error of Mean (logged)	0.319		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	2802
SD in Original Scale	6263
95% t UCL (Assumes normality)	4493

#### DL/2 Log-Transformed

Mean in Log Scale	5.773
SD in Log Scale	2.007
95% H-Stat UCL	8217

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Approximate Normal Distributed at 5% Significance Level**

### Suggested UCL to Use

95% KM (t) UCL	4540	95% KM (Percentile Bootstrap) UCL	4568
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## Aluminum

### General Statistics

Total Number of Observations	40	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	2700	Mean	9205
Maximum	25000	Median	8850
SD	4904	Std. Error of Mean	775.3
Coefficient of Variation	0.533	Skewness	1.415

### Normal GOF Test

Shapiro Wilk Test Statistic	0.886
5% Shapiro Wilk Critical Value	0.94
Lilliefors Test Statistic	0.132
5% Lilliefors Critical Value	0.14

### Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

### Lilliefors GOF Test

Data appear Normal at 5% Significance Level

**Data appear Approximate Normal at 5% Significance Level**

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 10511

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	10665
95% Modified-t UCL (Johnson-1978)	10540

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### Gamma GOF Test

A-D Test Statistic	0.325	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0804	<b>Kolmogrov-Smirnoff Gamma GOF Test</b>
5% K-S Critical Value	0.14	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

### Gamma Statistics

k hat (MLE)	4.013	k star (bias corrected MLE)	3.728
Theta hat (MLE)	2294	Theta star (bias corrected MLE)	2469
nu hat (MLE)	321	nu star (bias corrected)	298.3
MLE Mean (bias corrected)	9205	MLE Sd (bias corrected)	4767
		Approximate Chi Square Value (0.05)	259.3
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	257.9

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$ )	10590	95% Adjusted Gamma UCL (use when $n < 50$ )	10645
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0963	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

### Lognormal Statistics

Minimum of Logged Data	7.901	Mean of logged Data	8.998
Maximum of Logged Data	10.13	SD of logged Data	0.522

### Assuming Lognormal Distribution

95% H-UCL	10898	90% Chebyshev (MVUE) UCL	11637
95% Chebyshev (MVUE) UCL	12727	97.5% Chebyshev (MVUE) UCL	14240
99% Chebyshev (MVUE) UCL	17211		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	10480	95% Jackknife UCL	10511
95% Standard Bootstrap UCL	10461	95% Bootstrap-t UCL	10816
95% Hall's Bootstrap UCL	10908	95% Percentile Bootstrap UCL	10495
95% BCA Bootstrap UCL	10592		
90% Chebyshev(Mean, Sd) UCL	11531	95% Chebyshev(Mean, Sd) UCL	12584
97.5% Chebyshev(Mean, Sd) UCL	14047	99% Chebyshev(Mean, Sd) UCL	16919

### Suggested UCL to Use

95% Student's-t UCL 10511

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

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These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

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### Arsenic

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	1.1	Mean	4.815
Maximum	20.9	Median	3.7
SD	3.966	Std. Error of Mean	0.627
Coefficient of Variation	0.824	Skewness	2.274
Normal GOF Test			
Shapiro Wilk Test Statistic	0.777	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.198	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.871	95% Adjusted-CLT UCL (Chen-1995)	6.087
		95% Modified-t UCL (Johnson-1978)	5.909
Gamma GOF Test			
A-D Test Statistic	0.565	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.104	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.141	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.126	k star (bias corrected MLE)	1.983
Theta hat (MLE)	2.265	Theta star (bias corrected MLE)	2.428
nu hat (MLE)	170.1	nu star (bias corrected)	158.7
MLE Mean (bias corrected)	4.815	MLE Sd (bias corrected)	3.419
		Approximate Chi Square Value (0.05)	130.6
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	129.6
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	5.852	95% Adjusted Gamma UCL (use when n<50)	5.895
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0685	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

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Lognormal Statistics			
Minimum of Logged Data	0.0953	Mean of logged Data	1.319
Maximum of Logged Data	3.04	SD of logged Data	0.705

Assuming Lognormal Distribution			
95% H-UCL	6.07	90% Chebyshev (MVUE) UCL	6.489
95% Chebyshev (MVUE) UCL	7.274	97.5% Chebyshev (MVUE) UCL	8.364
99% Chebyshev (MVUE) UCL	10.5		

**Nonparametric Distribution Free UCL Statistics**  
**Data appear to follow a Discernible Distribution at 5% Significance Level**

Nonparametric Distribution Free UCLs			
95% CLT UCL	5.846	95% Jackknife UCL	5.871
95% Standard Bootstrap UCL	5.812	95% Bootstrap-t UCL	6.232
95% Hall's Bootstrap UCL	6.43	95% Percentile Bootstrap UCL	5.855
95% BCA Bootstrap UCL	6.093		
90% Chebyshev(Mean, Sd) UCL	6.696	95% Chebyshev(Mean, Sd) UCL	7.548
97.5% Chebyshev(Mean, Sd) UCL	8.731	99% Chebyshev(Mean, Sd) UCL	11.05

**Suggested UCL to Use**  
**95% Adjusted Gamma UCL 5.895**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.  
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.  
For additional insight the user may want to consult a statistician.

### Chromium (hexavalent)

General Statistics			
Total Number of Observations	4	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	2
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.31	Minimum Non-Detect	0.23
Maximum Detect	0.94	Maximum Non-Detect	0.3
Variance Detects	0.198	Percent Non-Detects	50%
Mean Detects	0.625	SD Detects	0.445
Median Detects	0.625	CV Detects	0.713
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.617	SD of Logged Detects	0.784

**Warning: Data set has only 2 Detected Values.**  
**This is not enough to compute meaningful or reliable statistics and estimates.**

**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**  
**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**

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**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**

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### Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.428	Standard Error of Mean	0.21
SD	0.298	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.923	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.774	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.059	95% KM Chebyshev UCL	1.345
97.5% KM Chebyshev UCL	1.742	99% KM Chebyshev UCL	2.522

### Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

### Gamma Statistics on Detected Data Only

k hat (MLE)	3.57	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.175	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	14.28	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.062	nu hat (KM)	16.5
		Adjusted Level of Significance ( $\beta$ )	0.00498
Approximate Chi Square Value (16.50, $\alpha$ )	8.315	Adjusted Chi Square Value (16.50, $\beta$ )	5.415
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	0.848	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	1.302

### Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.328	Mean in Log Scale	-2.036
SD in Original Scale	0.428	SD in Log Scale	1.701
95% t UCL (assumes normality of ROS data)	0.832	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	32093		

### DL/2 Statistics

#### DL/2 Normal

Mean in Original Scale	0.379
SD in Original Scale	0.384
95% t UCL (Assumes normality)	0.83

#### DL/2 Log-Transformed

Mean in Log Scale	-1.323
SD in Log Scale	0.94
95% H-Stat UCL	12.54

DL/2 is not a recommended method, provided for comparisons and historical reasons

### Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

### Suggested UCL to Use

95% KM (t) UCL	0.923	95% KM (% Bootstrap) UCL	N/A
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Warning: One or more Recommended UCL(s) not available!

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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

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### Cobalt

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.57	Mean	2.407
Maximum	5	Median	2.45
SD	0.862	Std. Error of Mean	0.136
Coefficient of Variation	0.358	Skewness	0.453
Normal GOF Test			
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.111	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.14	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.636	95% Adjusted-CLT UCL (Chen-1995)	2.641
		95% Modified-t UCL (Johnson-1978)	2.638
Gamma GOF Test			
A-D Test Statistic	0.451	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0969	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.14	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	7.123	k star (bias corrected MLE)	6.606
Theta hat (MLE)	0.338	Theta star (bias corrected MLE)	0.364
nu hat (MLE)	569.9	nu star (bias corrected)	528.5
MLE Mean (bias corrected)	2.407	MLE Sd (bias corrected)	0.936
		Approximate Chi Square Value (0.05)	476.2
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	474.3
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2.671	95% Adjusted Gamma UCL (use when n<50)	2.682
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.121	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			

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Lognormal Statistics			
Minimum of Logged Data	-0.562	Mean of logged Data	0.806
Maximum of Logged Data	1.609	SD of logged Data	0.409

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### Assuming Lognormal Distribution

95% H-UCL	2.749	90% Chebyshev (MVUE) UCL	2.915
95% Chebyshev (MVUE) UCL	3.136	97.5% Chebyshev (MVUE) UCL	3.441
99% Chebyshev (MVUE) UCL	4.041		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	2.631	95% Jackknife UCL	2.636
95% Standard Bootstrap UCL	2.63	95% Bootstrap-t UCL	2.636
95% Hall's Bootstrap UCL	2.648	95% Percentile Bootstrap UCL	2.618
95% BCA Bootstrap UCL	2.632		
90% Chebyshev(Mean, Sd) UCL	2.815	95% Chebyshev(Mean, Sd) UCL	3.001
97.5% Chebyshev(Mean, Sd) UCL	3.258	99% Chebyshev(Mean, Sd) UCL	3.762

### Suggested UCL to Use

95% Student's-t UCL 2.636

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Iron

### General Statistics

Total Number of Observations	40	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	3460	Mean	12730
Maximum	38000	Median	9700
SD	9195	Std. Error of Mean	1454
Coefficient of Variation	0.722	Skewness	1.506

### Normal GOF Test

Shapiro Wilk Test Statistic	0.817
5% Shapiro Wilk Critical Value	0.94
Lilliefors Test Statistic	0.195
5% Lilliefors Critical Value	0.14

### Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

### Lilliefors GOF Test

Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 15179

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 15491

95% Modified-t UCL (Johnson-1978) 15237

### Gamma GOF Test

A-D Test Statistic 0.706

### Anderson-Darling Gamma GOF Test

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5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.108	<b>Kolmogrov-Smirnoff Gamma GOF Test</b>
5% K-S Critical Value	0.141	Detected data appear Gamma Distributed at 5% Significance Level
<b>Detected data appear Gamma Distributed at 5% Significance Level</b>		

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### Gamma Statistics

k hat (MLE)	2.4	k star (bias corrected MLE)	2.237
Theta hat (MLE)	5303	Theta star (bias corrected MLE)	5690
nu hat (MLE)	192	nu star (bias corrected)	179
MLE Mean (bias corrected)	12730	MLE Sd (bias corrected)	8511
		Approximate Chi Square Value (0.05)	149
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	148

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when  $n \geq 50$ ) 15287      95% Adjusted Gamma UCL (use when  $n < 50$ ) 15393

### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0852	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	8.149	Mean of logged Data	9.229
Maximum of Logged Data	10.55	SD of logged Data	0.671

### Assuming Lognormal Distribution

95% H-UCL	15925	90% Chebyshev (MVUE) UCL	17038
95% Chebyshev (MVUE) UCL	19016	97.5% Chebyshev (MVUE) UCL	21760
99% Chebyshev (MVUE) UCL	27151		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	15121	95% Jackknife UCL	15179
95% Standard Bootstrap UCL	15116	95% Bootstrap-t UCL	15578
95% Hall's Bootstrap UCL	15722	95% Percentile Bootstrap UCL	15082
95% BCA Bootstrap UCL	15610		
90% Chebyshev(Mean, Sd) UCL	17091	95% Chebyshev(Mean, Sd) UCL	19067
97.5% Chebyshev(Mean, Sd) UCL	21809	99% Chebyshev(Mean, Sd) UCL	27196

### Suggested UCL to Use

95% Adjusted Gamma UCL 15393

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

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### Lead

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	4	Mean	80.44
Maximum	1100	Median	17.5
SD	201.4	Std. Error of Mean	31.84
Coefficient of Variation	2.503	Skewness	4.085

Normal GOF Test		Shapiro Wilk GOF Test	
Shapiro Wilk Test Statistic	0.408	Data Not Normal at 5% Significance Level	
5% Shapiro Wilk Critical Value	0.94	Lilliefors GOF Test	
Lilliefors Test Statistic	0.374	Data Not Normal at 5% Significance Level	
5% Lilliefors Critical Value	0.14		

**Data Not Normal at 5% Significance Level**

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	134.1	95% Adjusted-CLT UCL (Chen-1995)	154.8
		95% Modified-t UCL (Johnson-1978)	137.5

Gamma GOF Test		Anderson-Darling Gamma GOF Test	
A-D Test Statistic	4.64	Data Not Gamma Distributed at 5% Significance Level	
5% A-D Critical Value	0.81	Kolmogorov-Smirnov Gamma GOF Test	
K-S Test Statistic	0.293	Data Not Gamma Distributed at 5% Significance Level	
5% K-S Critical Value	0.147		

**Data Not Gamma Distributed at 5% Significance Level**

Gamma Statistics			
k hat (MLE)	0.53	k star (bias corrected MLE)	0.507
Theta hat (MLE)	151.8	Theta star (bias corrected MLE)	158.7
nu hat (MLE)	42.38	nu star (bias corrected)	40.54
MLE Mean (bias corrected)	80.44	MLE Sd (bias corrected)	113
		Approximate Chi Square Value (0.05)	26.95
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	26.53

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	121	95% Adjusted Gamma UCL (use when n<50)	122.9

Lognormal GOF Test		Shapiro Wilk Lognormal GOF Test	
Shapiro Wilk Test Statistic	0.881	Data Not Lognormal at 5% Significance Level	
5% Shapiro Wilk Critical Value	0.94	Lilliefors Lognormal GOF Test	
Lilliefors Test Statistic	0.162	Data Not Lognormal at 5% Significance Level	
5% Lilliefors Critical Value	0.14		

**Data Not Lognormal at 5% Significance Level**

### Lognormal Statistics

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Minimum of Logged Data	1.386
Maximum of Logged Data	7.003

Mean of logged Data	3.199
SD of logged Data	1.278

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### Assuming Lognormal Distribution

95% H-UCL	97.48	90% Chebyshev (MVUE) UCL	93.94
95% Chebyshev (MVUE) UCL	112.2	97.5% Chebyshev (MVUE) UCL	137.6
99% Chebyshev (MVUE) UCL	187.4		

### Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

### Nonparametric Distribution Free UCLs

95% CLT UCL	132.8	95% Jackknife UCL	134.1
95% Standard Bootstrap UCL	131.8	95% Bootstrap-t UCL	194.2
95% Hall's Bootstrap UCL	167.5	95% Percentile Bootstrap UCL	138
95% BCA Bootstrap UCL	155.6		
90% Chebyshev(Mean, Sd) UCL	176	95% Chebyshev(Mean, Sd) UCL	219.2
97.5% Chebyshev(Mean, Sd) UCL	279.3	99% Chebyshev(Mean, Sd) UCL	397.2

### Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 219.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Thallium

### General Statistics

Total Number of Observations	40	Number of Distinct Observations	29
Number of Detects	28	Number of Non-Detects	12
Number of Distinct Detects	21	Number of Distinct Non-Detects	11
Minimum Detect	0.054	Minimum Non-Detect	0.09
Maximum Detect	0.18	Maximum Non-Detect	5.7
Variance Detects	0.00112	Percent Non-Detects	30%
Mean Detects	0.107	SD Detects	0.0335
Median Detects	0.1	CV Detects	0.314
Skewness Detects	0.536	Kurtosis Detects	-0.384
Mean of Logged Detects	-2.285	SD of Logged Detects	0.317

### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.956	<b>Shapiro Wilk GOF Test</b>	
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.151	<b>Lilliefors GOF Test</b>	
5% Lilliefors Critical Value	0.167	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.104	Standard Error of Mean	0.00603
SD	0.0326	95% KM (BCA) UCL	0.114
95% KM (t) UCL	0.114	95% KM (Percentile Bootstrap) UCL	0.114

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95% KM (z) UCL	0.114	95% KM Bootstrap t UCL	0.115
90% KM Chebyshev UCL	0.122	95% KM Chebyshev UCL	0.13
97.5% KM Chebyshev UCL	0.142	99% KM Chebyshev UCL	0.164

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### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.228	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.114	<b>Kolmogrov-Smirnoff GOF</b>
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

### Gamma Statistics on Detected Data Only

k hat (MLE)	10.65	k star (bias corrected MLE)	9.533
Theta hat (MLE)	0.01	Theta star (bias corrected MLE)	0.0112
nu hat (MLE)	596.4	nu star (bias corrected)	533.8
MLE Mean (bias corrected)	0.107	MLE Sd (bias corrected)	0.0346

### Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	10.22	nu hat (KM)	817.2
Approximate Chi Square Value (817.21, $\alpha$ )	751.9	Adjusted Chi Square Value (817.21, $\beta$ )	749.5
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	0.113	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	0.114

### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.054	Mean	0.104
Maximum	0.18	Median	0.1
SD	0.029	CV	0.28
k hat (MLE)	13.82	k star (bias corrected MLE)	12.8
Theta hat (MLE)	0.00749	Theta star (bias corrected MLE)	0.00809
nu hat (MLE)	1106	nu star (bias corrected)	1024
MLE Mean (bias corrected)	0.104	MLE Sd (bias corrected)	0.0289
		Adjusted Level of Significance ( $\beta$ )	0.044
Approximate Chi Square Value (N/A, $\alpha$ )	950.8	Adjusted Chi Square Value (N/A, $\beta$ )	948.1
95% Gamma Approximate UCL (use when $n \geq 50$ )	0.112	95% Gamma Adjusted UCL (use when $n < 50$ )	0.112

### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.977	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0936	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.167	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.103	Mean in Log Scale	-2.308
SD in Original Scale	0.029	SD in Log Scale	0.273
95% t UCL (assumes normality of ROS data)	0.111	95% Percentile Bootstrap UCL	0.111
95% BCA Bootstrap UCL	0.111	95% Bootstrap t UCL	0.112
95% H-UCL (Log ROS)	0.112		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

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KM Mean (logged)	-2.31	95% H-UCL (KM -Log)	0.114
KM SD (logged)	0.311	95% Critical H Value (KM-Log)	1.797
KM Standard Error of Mean (logged)	0.0582		

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DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.435	Mean in Log Scale	-1.735
SD in Original Scale	0.7	SD in Log Scale	1.211
95% t UCL (Assumes normality)	0.621	95% H-Stat UCL	0.616
DL/2 is not a recommended method, provided for comparisons and historical reasons			

### Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

### Suggested UCL to Use

95% KM (t) UCL	0.114	95% KM (Percentile Bootstrap) UCL	0.114
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

## Vanadium

General Statistics			
Total Number of Observations	40	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	6.4	Mean	21.09
Maximum	54.2	Median	21.5
SD	10.2	Std. Error of Mean	1.613
Coefficient of Variation	0.484	Skewness	1.232

### Normal GOF Test

Shapiro Wilk Test Statistic	0.902
5% Shapiro Wilk Critical Value	0.94
Lilliefors Test Statistic	0.115
5% Lilliefors Critical Value	0.14

### Shapiro Wilk GOF Test

Data Not Normal at 5% Significance Level

### Lilliefors GOF Test

Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL	23.81
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#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	24.08
95% Modified-t UCL (Johnson-1978)	23.86

### Gamma GOF Test

A-D Test Statistic	0.558
5% A-D Critical Value	0.752
K-S Test Statistic	0.107
5% K-S Critical Value	0.14

### Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

### Kolmogrov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

### Gamma Statistics

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k hat (MLE)	4.545	k star (bias corrected MLE)	4.221
Theta hat (MLE)	4.64	Theta star (bias corrected MLE)	4.997
nu hat (MLE)	363.6	nu star (bias corrected)	337.7
MLE Mean (bias corrected)	21.09	MLE Sd (bias corrected)	10.27
		Approximate Chi Square Value (0.05)	296.1
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	294.6

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$ )	24.05	95% Adjusted Gamma UCL (use when $n < 50$ )	24.17
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.139	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	1.856	Mean of logged Data	2.935
Maximum of Logged Data	3.993	SD of logged Data	0.498

### Assuming Lognormal Distribution

95% H-UCL	24.83	90% Chebyshev (MVUE) UCL	26.48
95% Chebyshev (MVUE) UCL	28.86	97.5% Chebyshev (MVUE) UCL	32.17
99% Chebyshev (MVUE) UCL	38.66		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	23.74	95% Jackknife UCL	23.81
95% Standard Bootstrap UCL	23.76	95% Bootstrap-t UCL	24.42
95% Hall's Bootstrap UCL	24.6	95% Percentile Bootstrap UCL	23.84
95% BCA Bootstrap UCL	24.22		
90% Chebyshev(Mean, Sd) UCL	25.93	95% Chebyshev(Mean, Sd) UCL	28.12
97.5% Chebyshev(Mean, Sd) UCL	31.16	99% Chebyshev(Mean, Sd) UCL	37.13

### Suggested UCL to Use

95% Student's-t UCL	23.81
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

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### UCL Statistics for Data Sets with Non-Detects

#### User Selected Options

Date/Time of Computation 6/13/2014 11:07:52 AM  
From File ProUCL input.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

#### Arsenic

##### General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	16	Mean	24
Maximum	33	Median	23.5
SD	7.257	Std. Error of Mean	3.629
Coefficient of Variation	0.302	Skewness	0.345

**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**

**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**

**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**

##### Normal GOF Test

Shapiro Wilk Test Statistic	0.992
5% Shapiro Wilk Critical Value	0.748
Lilliefors Test Statistic	0.16
5% Lilliefors Critical Value	0.443

##### Shapiro Wilk GOF Test

Data appear Normal at 5% Significance Level

##### Lilliefors GOF Test

Data appear Normal at 5% Significance Level

**Data appear Normal at 5% Significance Level**

##### Assuming Normal Distribution

###### 95% Normal UCL

**95% Student's-t UCL 32.54**

###### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	30.64
95% Modified-t UCL (Johnson-1978)	32.64

##### Gamma GOF Test

A-D Test Statistic	0.193
5% A-D Critical Value	0.657
K-S Test Statistic	0.163
5% K-S Critical Value	0.395

##### Anderson-Darling Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

##### Kolmogrov-Smirnov Gamma GOF Test

Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

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### Gamma Statistics

k hat (MLE)	14.4	k star (bias corrected MLE)	3.767
Theta hat (MLE)	1.667	Theta star (bias corrected MLE)	6.372
nu hat (MLE)	115.2	nu star (bias corrected)	30.13
MLE Mean (bias corrected)	24	MLE Sd (bias corrected)	12.37
		Approximate Chi Square Value (0.05)	18.6
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$ )	38.89	95% Adjusted Gamma UCL (use when $n < 50$ )	N/A
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.997	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	2.773	Mean of logged Data	3.143
Maximum of Logged Data	3.497	SD of logged Data	0.308

### Assuming Lognormal Distribution

95% H-UCL	40.05	90% Chebyshev (MVUE) UCL	35.03
95% Chebyshev (MVUE) UCL	40.02	97.5% Chebyshev (MVUE) UCL	46.95
99% Chebyshev (MVUE) UCL	60.56		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	29.97	95% Jackknife UCL	32.54
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	34.89	95% Chebyshev(Mean, Sd) UCL	39.82
97.5% Chebyshev(Mean, Sd) UCL	46.66	99% Chebyshev(Mean, Sd) UCL	60.1

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### Suggested UCL to Use

95% Student's-t UCL 32.54

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Cobalt

### General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	0.73	Mean	1.108
Maximum	1.9	Median	0.9
SD	0.541	Std. Error of Mean	0.27
Coefficient of Variation	0.488	Skewness	1.746

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

### Normal GOF Test

Shapiro Wilk Test Statistic	0.8	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.329	Lilliefors GOF Test
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 1.744

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	1.804
95% Modified-t UCL (Johnson-1978)	1.783

### Gamma GOF Test

A-D Test Statistic	0.474	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.302	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

### Gamma Statistics

k hat (MLE)	6.732	k star (bias corrected MLE)	1.85
Theta hat (MLE)	0.165	Theta star (bias corrected MLE)	0.599

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nu hat (MLE)	53.86	nu star (bias corrected)	14.8
MLE Mean (bias corrected)	1.108	MLE Sd (bias corrected)	0.814
		Approximate Chi Square Value (0.05)	7.121
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.301	95% Adjusted Gamma UCL (use when n<50)	N/A
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.865	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.274	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	-0.315	Mean of logged Data	0.026
Maximum of Logged Data	0.642	SD of logged Data	0.431

### Assuming Lognormal Distribution

95% H-UCL	2.573	90% Chebyshev (MVUE) UCL	1.801
95% Chebyshev (MVUE) UCL	2.119	97.5% Chebyshev (MVUE) UCL	2.56
99% Chebyshev (MVUE) UCL	3.426		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	1.552	95% Jackknife UCL	1.744
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1.918	95% Chebyshev(Mean, Sd) UCL	2.286
97.5% Chebyshev(Mean, Sd) UCL	2.795	99% Chebyshev(Mean, Sd) UCL	3.797

### Suggested UCL to Use

95% Student's-t UCL 1.744

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## Cyanide

### General Statistics

Total Number of Observations	4	Number of Distinct Observations	2
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Number of Detects	1	Number of Non-Detects	3
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!**

**It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).**

**The data set for variable Cyanide was not processed!**

### Iron

#### General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	19000	Mean	27750
Maximum	36000	Median	28000
SD	7676	Std. Error of Mean	3838
Coefficient of Variation	0.277	Skewness	-0.124

**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**

**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**

**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**

#### Normal GOF Test

Shapiro Wilk Test Statistic	0.96	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level

**Data appear Normal at 5% Significance Level**

#### Assuming Normal Distribution

##### 95% Normal UCL

95% Student's-t UCL 36782

##### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 33808

95% Modified-t UCL (Johnson-1978) 36742

#### Gamma GOF Test

A-D Test Statistic	0.268	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	<b>Kolmogrov-Smirnoff Gamma GOF Test</b>
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

#### Gamma Statistics

k hat (MLE)	16.67	k star (bias corrected MLE)	4.333
Theta hat (MLE)	1665	Theta star (bias corrected MLE)	6404
nu hat (MLE)	133.3	nu star (bias corrected)	34.67

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MLE Mean (bias corrected)	27750	MLE Sd (bias corrected)	13330
		Approximate Chi Square Value (0.05)	22.2
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when $n \geq 50$ )	43337	95% Adjusted Gamma UCL (use when $n < 50$ )	N/A
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### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.226	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

### Lognormal Statistics

Minimum of Logged Data	9.852	Mean of logged Data	10.2
Maximum of Logged Data	10.49	SD of logged Data	0.288

### Assuming Lognormal Distribution

95% H-UCL	44231	90% Chebyshev (MVUE) UCL	39691
95% Chebyshev (MVUE) UCL	45092	97.5% Chebyshev (MVUE) UCL	52589
99% Chebyshev (MVUE) UCL	67314		

### Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

### Nonparametric Distribution Free UCLs

95% CLT UCL	34063	95% Jackknife UCL	36782
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	39264	95% Chebyshev(Mean, Sd) UCL	44479
97.5% Chebyshev(Mean, Sd) UCL	51717	99% Chebyshev(Mean, Sd) UCL	65936

### Suggested UCL to Use

95% Student's-t UCL 36782

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.

## Appendix I

ProUCL Output - Groundwater

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

General Statistics			
Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	210	Mean	297.5
Maximum	400	Median	290
SD	96.74	Std. Error of Mean	48.37
Coefficient of Variation	0.325	Skewness	0.137

**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**

**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**

**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**

Normal GOF Test		Shapiro Wilk GOF Test	
Shapiro Wilk Test Statistic	0.845		
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.288		
5% Lilliefors Critical Value	0.443	Data appear Normal at 5% Significance Level	

**Data appear Normal at 5% Significance Level**

### Assuming Normal Distribution

#### 95% Normal UCL

95% Student's-t UCL 411.3

#### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 380.6  
95% Modified-t UCL (Johnson-1978) 411.9

Gamma GOF Test		Anderson-Darling Gamma GOF Test	
A-D Test Statistic	0.499		
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.32		
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level	

**Detected data appear Gamma Distributed at 5% Significance Level**

Gamma Statistics			
k hat (MLE)	12.41	k star (bias corrected MLE)	3.269
Theta hat (MLE)	23.98	Theta star (bias corrected MLE)	91.02
nu hat (MLE)	99.26	nu star (bias corrected)	26.15
MLE Mean (bias corrected)	297.5	MLE Sd (bias corrected)	164.6
		Approximate Chi Square Value (0.05)	15.49
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

### Assuming Gamma Distribution

95% Approximate Gamma UCL (use when  $n \geq 50$ ) 502.1      95% Adjusted Gamma UCL (use when  $n < 50$ ) N/A

Lognormal GOF Test		Shapiro Wilk Lognormal GOF Test	
Shapiro Wilk Test Statistic	0.837		
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	

## Appendix I

ProUCL Output - Groundwater

AOC 6 TNT Subareas - Remedial Investigation

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Lilliefors Test Statistic	0.284	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.443	Data appear Lognormal at 5% Significance Level

**Data appear Lognormal at 5% Significance Level**

<b>Lognormal Statistics</b>			
Minimum of Logged Data	5.347	Mean of logged Data	5.655
Maximum of Logged Data	5.991	SD of logged Data	0.332

<b>Assuming Lognormal Distribution</b>			
95% H-UCL	525	90% Chebyshev (MVUE) UCL	444.2
95% Chebyshev (MVUE) UCL	510.7	97.5% Chebyshev (MVUE) UCL	603
99% Chebyshev (MVUE) UCL	784.2		

**Nonparametric Distribution Free UCL Statistics**  
**Data appear to follow a Discernible Distribution at 5% Significance Level**

<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	377.1	95% Jackknife UCL	411.3
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	442.6	95% Chebyshev(Mean, Sd) UCL	508.3
97.5% Chebyshev(Mean, Sd) UCL	599.6	99% Chebyshev(Mean, Sd) UCL	778.8

**Suggested UCL to Use**  
**95% Student's-t UCL 411.3**

**Recommended UCL exceeds the maximum observation**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

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## Appendix J

### Ecological Risk Assessment

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# Ecological Risk Assessment

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This appendix contains a screening ecological risk assessment (SERA), constituting Steps 1 and 2 of the ecological risk assessment (ERA) process, and the first step (Step 3A) of a baseline ecological risk assessment (BERA) for the Area of Concern (AOC) 6 TNT Subarea. The most recent previous ERA for the AOC 6 TNT Subarea was conducted as part of the Site Inspection (SI) report (CH2M HILL, 2012) and consisted of an ecological risk screening, constituting a SERA and an abbreviated version of BERA Step 3A. This screening involved a comparison of surface soil, subsurface soil, and groundwater data collected in 2008 with medium-specific ecological screening values (ESVs). Chemicals of Potential Concern (COPCs) were identified in each of these media. Surface water and sediment data collected adjacent to the site (in Penniman Lake) were also screened in the 2012 SI. However, since Penniman Lake has now received a site designation (AOC 9), any further evaluation of surface water and sediment offshore of AOC 6 has been deferred to the on-going Penniman Lake Remedial Investigation (RI) and is not addressed in this ERA.

The results of the 2012 SI were used to develop the sampling and analysis plan (SAP) for this RI. Additional surface soil, subsurface soil, and groundwater data were collected in 2013 to support this RI. The 2008 surface and subsurface soil data used in the 2012 SI are also included in this ERA. However, the 2008 groundwater data evaluated as part of the 2012 SI are not included in this ERA since they were collected using direct push technology (2013 samples are from permanent monitoring wells).

## J.1 Ecological Risk Assessment Process

This ERA was conducted in accordance with the *Navy Policy for Conducting Ecological Risk Assessments* (CNO, 1999) and the Navy guidance for implementing this ERA policy (NAVFAC, 2003; 2012). The Navy ERA policy and guidance, which describe a process consisting of eight steps organized into three tiers, are conceptually similar to the 8-step ERA process outlined in USEPA ERA guidance for the Superfund program (USEPA, 1997). For both sets of guidance, Steps 1 and 2 involve conducting a SERA using very conservative assumptions. The BERA represents Steps 3 through 7. The BERA uses less conservative (but more realistic) assumptions and site-specific data to refine the risk estimates from the SERA for components that fail the initial screening. Step 8 addresses risk management issues. The major differences between the Navy ERA policy/guidance and the USEPA ERA guidance are:

- Navy policy/guidance provides clearly defined criteria for exiting the ERA process at specific points
- Navy policy/guidance divides Step 3 (the first step of the BERA) into two distinct sub-steps (Steps 3A and 3B), with a potential exit point after Step 3A
- Navy policy/guidance incorporates risk management considerations throughout all tiers of the ERA process

ERAs are conducted using a tiered, step-wise approach and are punctuated with Scientific Management Decision Points (SMDPs). SMDPs represent points in the ERA process where agreement on conclusions, actions, or methodologies is needed so that the ERA process can continue (or terminate) in a technically defensible manner. The results of the ERA at a particular SMDP are used to determine how the ERA process should proceed, for example, to the next step in the process or directly to a later step. The process continues until a final decision has been reached (for example, remedial action if unacceptable risks are identified, or no further action if risks are acceptable). The process can also be iterative if data needs are

identified at any step; the needed data are collected and the process starts again at the point appropriate to the type of data collected.

The screening (preliminary) problem formulation is the first step of an ERA and establishes the goals, scope, and focus of the SERA. Step 1 of the ERA process is intended to answer two main questions:

- Do complete exposure pathways exist?
- Are sufficient data available to conduct the SERA?

If no complete exposure pathways exist, the ERA process terminates at Step 1 with a conclusion of negligible (acceptable) risk because exposure, and thus potential risk, can only occur if complete exposure pathways exist. If one or more complete exposure pathways are known to exist, or are likely to exist, the ERA process continues to Step 2 but only evaluates those exposure pathways that have been determined to be “critical” (ecologically important), that is, represent exposures to sensitive receptors that are associated with the predominant fate and transport mechanisms at the site (USEPA, 1997). An evaluation of the available data is then conducted to determine if they are adequate to support the SERA. If not, additional data are collected before the ERA process continues. The second step of the ERA process involves conducting a screening exposure assessment, a screening effects assessment, and a screening risk calculation (risk characterization).

The results of the SERA are used to evaluate the potential for unacceptable ecological risks based on very conservative assumptions. If the results of the SERA suggest that further ecological risk evaluation is warranted, the ERA process proceeds to the BERA (Steps 3 through 7), which is a more detailed phase of the ERA process, for the exposure pathways, chemicals, receptors, and areas identified in the SERA. As previously indicated, the first step of the BERA (Step 3) is divided into two distinct sub-steps (3A and 3B) in Navy ERA guidance.

Step 3 of the USEPA ERA guidance consists of the following activities (USEPA, 1997):

1. Refinement of the COPCs from the SERA
2. Further characterizing the potential ecological effects of contaminants
3. Refining information on contaminant fate and transport, complete exposure pathways, and receptors potentially at risk
4. Selecting assessment endpoints
5. Refining the conceptual site model and risk hypotheses from the SERA

Step 3A of the Navy policy/guidance (refinement of conservative exposure assumptions) corresponds to the first activity, previously listed, for the USEPA ERA guidance. In Step 3A, a refined evaluation of exposure estimates is conducted using less conservative (but more realistic) assumptions and additional methods relative to those used in the SERA, which is intended to be a very conservative assessment (NAVFAC, 2003). Examples of less conservative (but more realistic) exposure assumptions include using central tendency (such as means or medians) estimates (rather than maximums) for media concentrations, bioaccumulation factors (BAFs), and/or exposure parameters. Examples of additional methods include the consideration of background concentrations, bioavailability, and detection frequency (CNO, 1999; NAVFAC, 2003; 2012).

If risk estimates (and their associated uncertainty) are acceptable following Step 3A, the site will meet the conditions of the exit criterion specified in the Navy policy/guidance. If the Step 3A evaluation does not support a determination of acceptable risk within acceptable uncertainty, the site continues to Step 3B.

Step 3B of the Navy policy/guidance (problem formulation) corresponds conceptually to the last four activities, previously listed, for Step 3 of the USEPA ERA guidance. In Step 3B, the preliminary conceptual site model (CSM) from the SERA is refined based on the results of the Step 3A evaluation to develop a revised list of key receptors, critical exposure pathways, key COPCs, assessment endpoints, measurement endpoints, and risk hypotheses. Based on the refined CSM, the lines of evidence to be used in characterizing risk are determined. Agreement on the refined CSM, COPCs, exposure pathways, endpoints, and risk hypotheses constitutes the SMDP at the end of Step 3 in both Navy and USEPA ERA guidance.

Following the completion of Step 3, a decision point is reached with two potential outcomes. If the refined risk estimates are acceptable for each selected assessment endpoint, the investigation proceeds to risk characterization (Step 7) to document this conclusion, and the ERA process terminates. If the uncertainties associated with the refined risk estimates are unacceptable and/or the risk estimates indicate that unacceptable risks may exist, site-specific studies might be required and the ERA process continues (Steps 4 through 6). Step 4 is a work planning step where additional site-specific studies are scoped and designed. Step 5 consists of the verification of the field sampling design developed in Step 4 while Step 6 constitutes the site investigation and data analysis phase of the process. The scope (the spatial extent of sampling) and components (for example, the collection of biological data such as tissue samples and toxicity testing) of any site-specific studies are determined by the conclusions of Step 3 and the pathways/endpoints associated with the potential unacceptable risks.

Step 7 consists of the documentation and synthesis of the information and data identified in Steps 1 through 3 (no additional study) or Steps 1 through 6 (additional study). In this step, ecological risk is evaluated and characterized using both quantitative and qualitative methods. Conclusions are made as to whether or not there is a reasonable potential for unacceptable ecological risk, and if there is a potential for unacceptable ecological risk, the magnitude of that risk. The results of the completed BERA (Step 7) are used to make any necessary risk management decisions (Step 8) related to current or future risks. Possible decisions include:

- Adequate information is available to conclude that no unacceptable ecological risks exist. The assessment should stop at Step 7.
- Adequate information is available to conclude that unacceptable ecological risks exist for which remedial actions or controls are warranted. Whether remedial actions or controls are taken, and the specific actions or controls taken, will depend on a number of risk management factors such as the results of any human health risk assessments (if applicable) and the potential impact of the remedial action or control itself on the habitats and biota present. This analysis would occur as part of Step 8.
- Adequate information is not available to estimate risk or the risk estimate is believed to be too conservative or uncertain to recommend remediation. The assessment should be refined.

## J.2 Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. As part of problem formulation, the ecological setting of the AOC 6 TNT Subarea is characterized in terms of the habitats and biota known or likely to be present. The types and concentrations of chemicals that are present in ecologically relevant media are also described based on available analytical data. Surface soil (0 to 6 inches bgs) is the primary ecologically relevant terrestrial medium at the site. Subsurface soils (6 to 24 inches bgs) are also evaluated, per Region 3 BTAG guidance, because some ecological receptors may be exposed to soils at these depths. The evaluation of the surface water and sediment in Penniman Lake adjacent to the site has been deferred to the Penniman Lake RI. However, for this RI, site groundwater is evaluated as a potential transport medium to both Penniman Lake and King Creek.

A CSM is developed that describes source areas, transport pathways and exposure media, exposure pathways and routes, and receptors. Assessment endpoints, measurement endpoints, and risk hypotheses are developed to evaluate those receptors for which critical exposure pathways exist. The fate, transport, and toxicological properties of the chemicals present at the AOC 6 TNT Subarea, particularly the potential for bioaccumulation, are also considered during this process.

### J.2.1 Environmental Setting

AOC 6 is comprised of four small (each less than 1 acre in size) non-contiguous subareas: (1) the Ammonia Settling Pits Subarea, (2) the 1918 Drum Storage Area Subarea, (3) the Waste Slag Subarea, and (4) the TNT Graining House Sump and Catch Box Ruins Subarea. All of these subareas were related to the former Penniman Shell Loading Plant (PSLP). The PSLP was an explosives manufacturing facility operated during WWI on what is now CAX and adjacent properties. This facility operated as a TNT manufacturing plant beginning in approximately 1916, and subsequently began loading artillery shells in 1918. Between 1918 and 1925, the PSLP was demolished. The Navy established CAX on a portion of the PSLP property in 1942. The AOC 6 TNT Subarea is the subject of this RI; the other three AOC 6 subareas are being evaluated separately.

The AOC 6 TNT Subarea, approximately 0.5 acre in size, is located near the southwestern bank of Penniman Lake (a large freshwater lake) and just north of King Creek (a tidal, estuarine water body) (**Figure 1-3**). It is comprised of the remnants of the former TNT Graining House, its associated sump, and the ruins of the former TNT Catch Box. The ruins of the Catch Box currently consist of an earthen, brick-lined depression located immediately east of the former TNT Graining House. The TNT Catch Box was used to separate TNT particles from wastewater associated with TNT Graining House processes. Only the concrete footprint of the former TNT Graining House currently exists on the site, as does a concrete-lined, open top pit believed to be the sump pit for the TNT Graining House. On September 19, 2013, the former TNT Graining House sump, located within the footprint of the TNT Graining House, was inspected. The concrete sump compartment measured 8 feet long, 2.5 feet wide, and 3.6 feet in depth, and contained about 2 feet of water above the bottom of the sump. Leaves, roots, and less than two inches of organic detritus, but not any residual material from former operations, was found on the bottom of the sump. Historical leaks and/or discharges from the former TNT Graining House sump and/or TNT Catch Box are the primary known/suspected sources of contamination at the AOC 6 TNT Subarea.

The AOC 6 TNT Subarea is currently wooded. Soils are somewhat acidic, with an average pH of 5.2 in surface soils and 5.4 in shallow subsurface soils (**Table J-1**). Total organic carbon (TOC) averages just over 3 percent in surface soils but less than 1 percent in shallow subsurface soils. Surface soils are comprised mainly of fine and medium sand, with about 10 to 20 percent silt/clay (**Table J-1**).

While the site does not contain any wetlands or water bodies, Penniman Lake occurs approximately 50 feet east of the ruins of the Catch Box, and King Creek occurs about 100 feet south (across Garrison Road) of the remnants of the TNT Graining House (**Figure 1-3**). An earthen berm occurs just north of the former TNT Graining House, rising about 15 feet above the surrounding grade. The topography on the remainder of the site is relatively flat but drops somewhat abruptly at the shoreline of Penniman Lake, and less abruptly south of Garrison Road toward King Creek (**Figure 3-1**). Surface runoff from the location of the former TNT Graining House and TNT Catch Box flows primarily east toward Penniman Lake. Due to the presence of Garrison Road, surface runoff from the locations of the former site structures is unlikely to reach King Creek. Groundwater (Columbia aquifer) was first encountered during RI sampling at a depth of about 5 to 8 feet bgs and flows primarily south toward King Creek (**Figure 3-5**). However, during low water conditions (such as in times of drought), groundwater could also potentially discharge into Penniman Lake.

The area that includes the AOC 6 TNT Subarea is currently used by Navy and DoD personnel for recreational activities such as jogging, hunting, and fishing. Future land use at the AOC 6 TNT Subarea is not expected to change and will likely continue as recreational into the foreseeable future.

### J.2.2 Analytical Data Used in the ERA

Both existing surface and shallow subsurface soil (from 2008), and surface soil, shallow subsurface soil, and groundwater samples collected as part of this RI (in 2013) were quantitatively evaluated in this ERA. Since ecological exposures are generally confined to the top two feet of the soil column, the soil data used in this ERA were confined to this depth range but were evaluated separately as surface samples (0 to 6 inches) and shallow subsurface samples (6 to 24 inches); terrestrial food web exposures only considered the surface soil samples. The results from the two surface water samples collected from Penniman Lake (in 2008) for the SI were used to represent drinking water exposures in terrestrial food web models.

All but one of the soil samples were discrete samples. However, one 3-point composite surface (0 to 6 inches bgs) and one 3-point composite subsurface (6 to 24 inches bgs) soil samples were collected from the surface depression at the AOC 6 TNT Catch Box Ruins to account for the potential variability of contaminant concentrations within this area. One of the composite sample points was located at the lowest point of the depression, at the center of the ruins of the TNT Catch Box. This point was in the vicinity of SI soil sample location CAA06-SO01, where the highest detections of explosives and metals were observed in surface and subsurface soils during the SI. The two other composite sample points were located 18 inches to the north and 18 inches to the south of the first composite sample point.

On September 19, 2013, the former TNT Graining House sump, located within the footprint of the former TNT Graining House was inspected. The concrete sump compartment measured 8 feet long, 2.5 feet wide, and 3.6 feet in depth, and water was observed at 2.2 feet above the bottom of the sump. Leaves, roots, less than two inches of organic detritus, and pieces of scraped concrete was recovered via a 3-inch auger bucket. As per the AOC 6 TNT Subarea SAP (CH2M HILL, 2013), no “sediment” sample was collected since residual material possibly related to the former ordnance plant processes was not present.

Although ecological receptors do not have direct exposure to groundwater, groundwater data collected as part of this RI were also evaluated in this ERA. This was done to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to potential downgradient receiving water bodies (Penniman Lake and King Creek) and the subsequent potential exposure of ecological receptors in these water bodies. Only the groundwater data collected (from permanent monitoring wells) in 2013 for this RI were quantitatively evaluated in this ERA. The historical (2008) groundwater data used in the 2012 SI were not included because they were direct push samples.

The surface water and sediment data collected adjacent to the site (in Penniman Lake) and screened in the 2012 SI were not quantitatively evaluated in this ERA (except for the inclusion of the surface water data in the terrestrial food web models). Since Penniman Lake has now received a site designation (AOC 9), any further evaluation of surface water and sediment offshore of the AOC 6 TNT Subarea has been deferred to the Penniman Lake RI.

Background soil UTLs from the Yorktown-CAX background study (CH2M HILL, 2011) were also considered in the ERA. Because the background study does not contain background UTL values for the Columbia aquifer, two of the wells (CAA06-MW01 and CAA06-MW06; **Figure 2-3**) located upgradient of the AOC 6 TNT Subarea source areas were used to represent site-specific background for groundwater. The remaining four wells were considered site wells.

The samples used in this ERA are listed in **Table J-2** and locations are shown on **Figures 2-1 through 2-3**. The analytical results for these samples can be found in **Appendix G**.

### J.2.3 Conceptual Site Model

The CSM relates potentially exposed receptor populations with potential source areas based on physical site characteristics and complete exposure pathways. Important components of the CSM are the identification of potential source areas, transport pathways, exposure media, exposure pathways and routes, and receptors. Actual or potential exposures of ecological receptors associated with a site are determined by identifying the most likely, and most important, mechanisms and pathways of contaminant release and transport. A complete exposure pathway has three components: (1) a source or sources of contamination that results in a release to the environment; (2) a pathway and mechanism of chemical transport through an environmental medium; and (3) an exposure or contact point for an ecological receptor. **Figure J-1** illustrates a diagrammatic CSM for the AOC 6 TNT Subarea. Key components of this CSM are discussed in the following subsections.

#### J.2.3.1 Source Areas

The potential sources of contamination at the AOC 6 TNT Subarea are the former TNT Catch Box and the former TNT Graining House (including the associated sump).

#### J.2.3.2 Transport Pathways and Exposure Media

A transport pathway describes the mechanisms whereby site-related chemicals, once released, may be transported from a source to ecologically relevant media (such as surface soil) where exposures may occur. These transport pathways are shown on **Figure J-1**.

The primary release mechanisms and transport pathways at the site include:

- Surface runoff from site-related source areas to other terrestrial areas of the AOC 6 TNT Subarea
- Uptake from the surface soil and accumulation in the tissues of terrestrial biota
- Infiltration, percolation, and leaching of contaminants to groundwater and subsequent discharge to the surface water and sediment of Penniman Lake and King Creek
- Surface runoff from site-related source areas to Penniman Lake
- Uptake from the surface water and sediment of Penniman Lake and accumulation in the tissues of aquatic biota

Only the first three of these mechanisms/pathways are evaluated in this ERA. The remaining two, related to the surface water and sediment of Penniman Lake, will be evaluated further in the Penniman Lake RI. Concentration gradients from potential source areas through the appropriate pathway(s) are evaluated in order to determine if there are any links between site contamination and potential ecological receptors (habitats and biota).

Exposure media for ecological receptors are typically limited to surface water, surface sediment, and surface soil. As noted above, an evaluation of surface water and sediment has been deferred to the Penniman Lake RI. Shallow subsurface soils (6 to 24 inches bgs) are also evaluated in this ERA because some ecological receptors may be exposed to soils at these depths. Groundwater is generally considered only as a transport medium since there are no ecological exposures to groundwater until it discharges to a water body or surfaces as a seep. In this ERA, groundwater is evaluated as a potential transport medium to downgradient water bodies (Penniman Lake and King Creek). Air is not addressed in this ERA since this medium is not likely

to result in significant contributions to total exposures for metals and explosives (the key COPCs from the ecological risk screening in the 2012 SI).

### J.2.3.3 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. **Figure J-1** shows the potentially complete exposure pathways to ecological receptors associated with the AOC 6 TNT Subarea.

Complete exposure pathways exist to lower trophic level terrestrial receptors (plants, soil invertebrates, reptiles, and amphibians) from direct contact with surface soil, and to terrestrial upper trophic level receptors (birds, mammals, reptiles, and amphibians) from incidental ingestion of surface soil and exposure via terrestrial food webs. There is the potential for transport, primarily through surface runoff, from AOC 6 TNT Subarea source areas to Penniman Lake, and subsequent exposure, via direct contact and/or direct ingestion of surface water and surface sediment, to lower trophic level aquatic receptors (aquatic plants, aquatic and benthic invertebrates, fish, amphibians, and reptiles), as well as to upper trophic level aquatic receptors (birds, mammals, fish, amphibians, and reptiles) via direct ingestion (water), incidental ingestion (sediment), and exposure via aquatic food webs. However, potential aquatic exposures in Penniman Lake will be evaluated as part of the Penniman Lake RI and not in this ERA.

There is the potential for groundwater transport and subsequent discharge from the site to Penniman Lake (freshwater) and King Creek (tidal, estuarine). Groundwater is evaluated as a potential transport medium to these downgradient water bodies in this ERA.

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. The most common exposure routes are dermal contact, direct uptake, ingestion, and inhalation. Terrestrial plants may be exposed to chemicals present in surface soil through their root surfaces during water and nutrient uptake. Unrooted, floating aquatic plants, rooted submerged vascular aquatic plants, and algae may be exposed to chemicals directly from the water or (for rooted plants) from sediment. Terrestrial and aquatic/benthic invertebrates may be exposed to chemicals in surface soil, surface sediment, and/or surface water through direct contact and ingestion.

Animals may be exposed to chemicals through the: (1) inhalation of gaseous chemicals or of chemicals adhered to airborne particulate matter; (2) incidental ingestion of contaminated abiotic media (soil and/or sediment) during feeding or preening activities; (3) ingestion of contaminated water; (4) ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. These routes, where applicable, are depicted on **Figure J-1**.

Direct contact is the primary exposure route for lower trophic level receptors (plants, invertebrates, reptiles, and amphibians) at the site. Incidental ingestion of soil/sediment and exposure via food webs are the primary exposure routes for upper trophic level receptors (birds, mammals, fish, amphibians, and reptiles). The contribution to the total dose from the inhalation route is generally insignificant for upper trophic level ecological receptors relative to ingestion pathways. Thus, the inhalation pathway is not generally considered for ecological receptors and was not evaluated in this ERA. Exposure to chemicals present in surface soil and surface sediment via dermal contact may occur but is unlikely to represent a major exposure pathway for most upper trophic level receptors because fur or feathers minimize transfer of chemicals across dermal tissue. Thus, dermal contact was not evaluated for upper trophic level receptors in this ERA. Incidental ingestion of surface soil during feeding, preening, or grooming activities was, however, considered in the risk estimates for terrestrial food web exposures. Direct contact was, however, considered for lower trophic level terrestrial receptors (soil invertebrates).

Direct ingestion of drinking water is only considered when a permanent or semi-permanent source of water with a salinity below 15 parts per thousand (ppt), the approximate toxic threshold for wildlife receptors (Humphreys, 1988), exists on a site. Penniman Lake meets these criteria. Thus, exposure via direct ingestion of drinking water from Penniman Lake was included in the evaluation of terrestrial food web exposures for the AOC 6 TNT Subarea.

#### J.2.3.4 Receptors

Because of the complexity of natural systems, it is generally not practical to directly assess the potential impacts to all ecological receptors present at a site. Therefore, specific receptor species (such as red-tailed hawk) or species groups (such as plants) are selected as surrogates to evaluate potential risks to larger components of the ecological community (guilds; such as carnivorous birds) used to represent the assessment endpoints (such as survival and reproduction of carnivorous birds). Selection criteria typically include those species that:

- Are known to occur, or are likely to occur, at the site
- Have a particular ecological, economic, or aesthetic value
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present for which complete exposure pathways are likely to exist
- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations

The following upper trophic level receptor species have been chosen for exposure modeling in terrestrial habitats based on the previously listed criteria and the habitats present on the site:

- Mourning dove (*Zenaida macroura*) – terrestrial avian herbivore
- American robin (*Turdus migratorius*) – terrestrial avian omnivore/invertivore (modeled as both)
- Red-tailed hawk (*Buteo jamaicensis*) – terrestrial avian carnivore
- Meadow vole (*Microtus pennsylvanicus*) – terrestrial mammalian herbivore
- Short-tailed shrew (*Blarina brevicauda*) – terrestrial mammalian invertivore
- White footed mouse (*Peromyscus leucopus*) – terrestrial mammalian omnivore
- Red fox (*Vulpes vulpes*) – terrestrial mammalian carnivore

Upper trophic level receptors quantitatively evaluated in the ERA were limited to birds and mammals, the taxonomic groups with the most available information regarding exposure and toxicological effects. Lower trophic level receptors were evaluated based on those taxonomic groupings for which medium-specific ESVs have been developed. As such, specific species of terrestrial biota (plants and soil invertebrates) were not chosen as receptors because of the limited information available for specific species and because these receptors were evaluated on a community level via a comparison of chemical concentrations in soil to soil ESVs developed for these groups.

Amphibians and reptiles are also applicable receptor groups. Individual species of amphibians and reptiles were not, however, selected for evaluation because of the general lack of available toxicological information for these taxonomic groups for direct effects (reptiles) and effects from exposures via food webs (reptiles and amphibians). Potential risks to amphibians and reptiles from food web exposures were evaluated using other fauna (birds and mammals) as surrogates. Similarly, potential risks to these groups from direct exposures to surface soil were evaluated using ESVs developed for other taxonomic groups (described above). This is discussed further in **Section J.6** (uncertainties).

No federally or state-listed endangered or threatened species are currently known to occur on or near the AOC 6 TNT Subarea.

### J.2.3.5 Endpoints and Risk Hypotheses

The conclusion of the problem formulation includes the selection of ecological endpoints and risk hypotheses, which are based on the CSM. Two types of endpoints, assessment endpoints and measurement endpoints, are defined as part of the ERA process (USEPA, 1997). An assessment endpoint is an explicit expression of the environmental component or value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint. The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1997) and discussed in detail in Suter (1989; 1990; 1993). Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to contaminants.

Endpoints define ecological attributes that are to be protected (assessment endpoints) and measurable characteristics of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or may occur. Assessment endpoints most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to a site (USEPA, 1997). Assessment endpoints contain an entity (such as hawk population) and an attribute of that entity (such as survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor) with some common characteristic, such as specific exposure route or contaminant sensitivity, with the receptor then used to represent the assessment endpoint in the risk evaluation.

Assessment and measurement endpoints may involve ecological components from any level of biological organization, from individual organisms to the ecosystem itself. Effects on individual organisms are important for some receptors, such as rare and endangered species; population- and community-level effects are typically more relevant to ecosystems. Population- and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population or community level. In addition, use of criteria values designed to protect the majority of the components of a community (such as the Ambient Water Quality Criteria [AWQC] for the Protection of Aquatic Life) can be useful in evaluating potential community- and/or population-level effects.

**Table J-3** shows the assessment endpoints, risk hypotheses, and measurement endpoints used in the ERA. **Table J-3** also shows the receptors associated with each endpoint.

## J.3 Exposure Assessment

The principal activity associated with the exposure assessment is the estimation of chemical concentrations in applicable media, termed exposure point concentrations (EPCs), to which the receptors may be exposed. This is accomplished through the selection of appropriate sets of the available analytical data using a set of criteria (such as validation status and sampling date). Once the analytical data sets are selected, EPCs are calculated as a particular point on the distribution of concentrations. At the screening level (SERA; Step 2), the EPC is the maximum detected concentration. At the baseline level (BERA; Step 3A), EPCs are central tendency estimates (such as the arithmetic mean). EPCs are then used in bioaccumulation and food web models to estimate exposures to upper trophic level receptors.

For conservatism, the maximum (SERA) and mean (BERA) reporting limits for chemicals analyzed for but not detected were also compared to medium-specific ESVs and (where applicable) used for food web exposure modeling. This was done to determine if reporting limits were less than chemical concentrations at which potential adverse effects to ecological receptors may occur.

### J.3.1 Selection Criteria for Analytical Data

Available analytical data (described in **Section J.2.2**) were selected for use in the ERA based on the following:

- Data must have been validated by a qualified data validator using acceptable data validation methods. Rejected (R) values were not used in the ERA. Unqualified data and data qualified as J (estimated), L (biased low), or K (biased high) were treated as detected. Data qualified as U (undetected) or B (blank contamination) were treated as non-detected.
- For samples with duplicate analyses, the higher of the two concentrations was used, for conservatism, when both values were detects or when both values were non-detects. In cases where one result was a detection and the other a non-detect, the detected value was used in the assessment.
- For non-detected results, the sample quantitation (reporting) limit (SQL) was used to represent the concentration. When calculating statistics (such as the arithmetic mean), one-half of the SQL was used for non-detected results.

### J.3.2 Exposure Point Concentrations

EPCs are calculated as a particular point on the distribution of concentrations. At the screening level (SERA; Step 2), the EPC is the maximum detected concentration. At the baseline level (BERA; Step 3A), EPCs are central tendency estimates, which provide a more representative estimate of potential exposures and risks to receptor populations (the focus of the selected assessment endpoints). In this ERA, the maximum, arithmetic mean, and 95% upper confidence limit (UCL) of the arithmetic mean concentrations were evaluated for direct exposures. Exposures via food webs also utilized the maximum, arithmetic mean, and 95% UCL of the arithmetic mean. If the calculated 95% UCL and/or mean concentrations were greater than the maximum detected concentration, the maximum detected concentration was used in place of the 95% UCL and/or mean concentrations.

These three medium-specific EPCs were also used in bioaccumulation and food web models to estimate exposures to upper trophic level receptors. Dietary items for which tissue concentrations were modeled included terrestrial plants, soil invertebrates, and small mammals. Incidental ingestion of surface soil, and ingestion of drinking water, were included when calculating the total dietary exposure. The models and parameter values used for calculating the tissue concentrations are outlined in the following subsections.

Not all chemicals were evaluated for food web exposures. Only those chemicals with the potential to bioaccumulate to a significant extent, as defined in Table 4-2 of USEPA (2000), were evaluated. This list of bioaccumulating chemicals is provided in **Table J-4** for chemicals relevant to the AOC 6 TNT Subarea.

For the screening (SERA) exposure estimates, the uptake of chemicals from the abiotic media into food items was based on conservative (e.g., 90<sup>th</sup> percentile) bioconcentration factors (BCFs) or bioaccumulation factors (BAFs) from the literature, where available. The 90<sup>th</sup> percentile is generally recommended to provide for a conservative screening assessment (Sample et al., 1998a; 1998b; Bechtel Jacobs, 1998b). If 90<sup>th</sup> percentile values were not available in the cited reference, the maximum value was used, if available. If only central tendency (such as median) values were reported, they were used for both the SERA and BERA. Where an individual study (as opposed to a compilation of multiple studies) was cited, the best available value was sometimes a single value or the derivation was not specified. Default (assumed) factors of 1.0 were used only when data were not readily available for a chemical in the literature. In some cases, chemical

concentrations in food items were directly estimated from maximum surface soil concentrations using available literature-based regression models.

BCFs and BAFs used for baseline (BERA) exposure estimates were based on, or modeled from, central tendency estimates (such as median or mean). Baseline values considered both the distribution of the data (normal or log normal) and the recommendations in the cited reference. Geometric means were preferred for log normal distributions and arithmetic means for normal distributions. In some cases, neither distribution was applicable or the distribution was biased by an outlying value. In these cases, point estimates like the median were then considered. Where an individual study (as opposed to a compilation of multiple studies) was cited, the best available value was sometimes a single value or the derivation was not specified. Default (assumed) factors of 1.0 were used only when data were not readily available for a chemical in the literature. In some cases, chemical concentrations in food items were directly estimated from mean and 95% UCL surface soil concentrations using available literature-based regression models.

In the BERA, using central tendency estimates (rather than high-end values or maximums) for exposure parameters such as BAFs provides a more representative estimate of potential exposures and risks to receptor populations (which are the focus of the selected assessment endpoints) of upper trophic level receptors. Since these upper trophic level species are highly mobile, they would be expected to effectively average their exposure over time as they forage within the area defining their home range. Average prey concentrations are most appropriately estimated using central tendency estimates of media concentrations and accumulation factors. For example, the wildlife dietary exposure models contained in the *Wildlife Exposure Factors Handbook* (USEPA, 1993) specify the calculation of an average daily dose. Increasing the representativeness of the exposure estimates relative to population-level effects is consistent with the intent of the BERA. In cases where adequate spatial sampling coverage exists, mean concentrations are also appropriate for evaluating potential risks to populations of lower trophic level receptors because the members of the population are expected to be found throughout a site (where suitable habitat is present), rather than concentrated in one particular area. While effects on individual organisms might be important for some receptors, such as rare and endangered species, population- and community-level effects are typically more relevant to ecosystems. For this ERA, the receptor populations of interest are those that utilize all or part of the site, but such use is not necessarily exclusive to the site for the entire population. However, the exposure estimates in this ERA conservatively assume that the receptors receive 100 percent of their exposure from the site.

For direct exposures to soil, PAHs were evaluated based on the sum total concentration of the individual constituents for the high molecular weight (HMW) and low molecular weight (LMW) fractions.

#### J.3.2.1 Terrestrial Plants

For most chemicals, tissue concentrations in the aboveground vegetative portion of terrestrial plants were estimated by multiplying the maximum (SERA) or mean and 95% UCL (BERA) surface soil concentration for each bioaccumulative chemical by chemical-specific soil-to-plant BAFs obtained from the literature. These BAFs, for both the SERA and BERA, are listed in **Table J-5**. For some chemicals, tissue concentrations were directly estimated from surface soil concentrations using regression equations; these algorithms are listed in **Table J-6**.

The BAF values used were based on root uptake from soil and on the ratio between dry-weight soil and dry-weight plant tissue. Literature values based on the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BAF by an estimated solids content for terrestrial plants (15 percent [0.15] [Sample et al., 1997]).

For inorganic chemicals lacking literature-based, chemical-specific BAFs or applicable algorithms, a soil-to-plant BAF of 1.0 was used. For non-ionic organic chemicals (with a log  $K_{ow}$  of between 3 and 8) without literature-based BAFs, soil-to-plant BAFs were estimated using the rinsed foliage algorithm provided on Figure 5B of USEPA (2007h):

$$\log BAF = (-0.4057) (\log K_{ow}) + 1.781$$

where: BAF = Soil-to-plant BAF (unitless; dry-weight basis)  
 $K_{ow}$  = Octanol-water partitioning coefficient (unitless)

The log  $K_{ow}$  values used in this equation are listed in **Table J-4**.

### J.3.2.2 Soil Invertebrates (Earthworms)

For most chemicals, tissue concentrations in soil invertebrates (earthworms) were estimated by multiplying the maximum (SERA) or mean and 95% UCL (BERA) surface soil concentration for each bioaccumulative chemical by chemical-specific soil-to-invertebrate BCFs or BAFs obtained from the literature. These BCF/BAF values, for both the SERA and BERA, are listed in **Table J-7**. For some chemicals, tissue concentrations were directly estimated from surface soil concentrations using regression equations; these algorithms are listed in **Table J-6**.

BCFs are calculated by dividing the concentration of a chemical in earthworm tissue by the concentration of that same chemical in the surrounding environmental medium (surface soil) without accounting for uptake via the diet. BAFs consider both direct exposure to soil and exposure via the diet. Because earthworms consume soil, BAFs are more appropriate values and were used when available. BAFs based on depurated analyses (soil was purged from the gut of the earthworm prior to analysis) were given preference over undepurated analyses when selecting BAF values because direct ingestion of soil is accounted for separately in the food web model.

The BCF/BAF values selected were based on the ratio between dry-weight soil and dry-weight earthworm tissue. Literature values based on the ratio between dry-weight soil and wet-weight earthworm tissue were converted to a dry-weight basis by dividing the wet-weight BCF/BAF by the estimated solids content for earthworms (16 percent [0.16]; USEPA, 1993). For chemicals without available measured BAFs/BCFs, an earthworm BAF was estimated using available regression equations from the literature, was estimated using data for similar chemicals, or a BAF of 1.0 was assumed.

### J.3.2.3 Small Mammals

Whole-body tissue concentrations in small mammals (omnivores, herbivores, and insectivores) were estimated using one of two methodologies. For chemicals with literature-based soil-to-small mammal BAFs, the small mammal tissue concentration was calculated by multiplying the maximum (SERA) or mean and 95% UCL (BERA) surface soil concentration for each bioaccumulative chemical by a chemical-specific soil-to-small mammal BAF obtained from the literature. These BAFs, for both the SERA and BERA, are listed in **Tables J-8 through J-10**. For some chemicals, tissue concentrations were directly estimated from surface soil concentrations using regression equations; these algorithms are listed in **Table J-6**.

The BAF values selected were based on the ratio between dry-weight soil and whole-body dry-weight tissue. Literature values based on the ratio between dry-weight soil and wet-weight tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for small mammals (32 percent [0.32] [USEPA, 1993]).

For chemicals without soil-to-small mammal BAF values or algorithms, an alternate approach was used to estimate whole-body tissue concentrations. Because most chemical exposure for these small mammals is via

the diet, it was assumed that the concentration of each bioaccumulative chemical in the small mammal's tissues was equal to the chemical concentration in its diet multiplied by a diet to whole-body BAF derived from the literature. The small mammal tissue concentration was calculated as follows:

$$TC_x = [(\sum_i (FC_{xi})(PDF_i)) + [(SC_x)(PDS)]] (BAF_{\text{diet-whole body}})$$

where:	$TC_x$	=	Small mammal tissue concentration for chemical x (mg/kg, dry weight)
	$FC_{xi}$	=	Concentration of chemical x in food item i (mg/kg, dry weight)
	$PDF_i$	=	Proportion of diet composed of food item i (dry weight basis)
	$SC_x$	=	Concentration of chemical x in soil (mg/kg, dry weight)
	$PDS$	=	Proportion of diet composed of soil (dry weight basis)
	$BAF$	=	Diet to whole-body BAF (unitless, dry weight basis)

This equation is basically a weighted average of the chemical concentration in the various dietary components (including soil ingestion) for the small mammal (vole, shrew, and mouse, weighted equally), multiplied by a diet-to-whole body BAF, and thus excludes water ingestion.

For chemicals lacking diet to whole-body BAF values (not to be confused with the soil-to-small mammal BAFs listed in **Tables J-8 through J-10**), a diet to whole-body BAF of one was assumed. The use of a diet to whole-body BAF of one is likely to result in a conservative estimate of chemical concentrations for chemicals that are not known to biomagnify in terrestrial food webs and a reasonable estimate of chemical concentrations for chemicals that are known to bioaccumulate or biomagnify, based on reported literature values. For example, a maximum diet to whole-body BAF value of 1.0 was reported by Simmons and McKee (1992) for PCBs based on laboratory studies with white-footed mice. Menzie et al. (1992) reported diet to whole-body BAF values for DDT of 0.3 for voles and 0.2 for short-tailed shrews. Reported diet to whole-body BAF values for dioxin were only slightly above 1 (1.4) for the deer mouse (USEPA, 1990).

#### J.3.2.4 Dietary Intakes

Upper trophic level receptor exposures via food webs to chemicals present in surface soil were determined using estimated chemical concentrations in each relevant dietary component for each upper trophic level receptor, as described in the previous subsection. Incidental ingestion of surface soil was also included when calculating the total dose. Drinking water exposures were also included.

Dietary intakes for each upper trophic level receptor were calculated using the following formula (modified from USEPA [1993]):

$$DI_x = \frac{[(\sum_i (FIR)(FC_{xi})(PDF_i)) + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

where:	$DI_x$	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
	$FIR$	=	Food ingestion rate (kg/day, dry-weight)
	$FC_{xi}$	=	Concentration of chemical x in food item i (mg/kg, dry-weight)
	$PDF_i$	=	Proportion of diet composed of food item i (dry-weight basis)
	$SC_x$	=	Concentration of chemical x in soil (mg/kg, dry-weight)
	$PDS$	=	Proportion of diet composed of soil (dry-weight basis)
	$WIR$	=	Water ingestion rate (L/day)
	$WC_x$	=	Concentration of chemical x in water (mg/L)
	$BW$	=	Body weight (kg)

Incidental ingestion of soil was modeled as a dietary component rather than using a separate soil ingestion rate. Parameter values for the selected receptors are listed in **Tables J-11** (SERA) and **J-12** (BERA). When measured food ingestion rates were not available for a receptor from the literature, the rates were estimated using allometric equations from Nagy (2001). When measured water ingestion rates were not available for a receptor from the literature, the rates were estimated using allometric equations from USEPA (1993). For receptors that consume small mammals (red fox and red-tailed hawk), it was assumed that the small mammal portion of the diet was composed of equal parts voles (herbivores), shrews (insectivores), and mice (omnivores).

The exposure parameter values were selected to provide for a conservative evaluation at the screening level (Step 2). Examples of these conservative assumptions include:

- All of the dietary items consumed by the receptor are obtained from the site (an Area Use Factor [AUF] of 1 was assumed) at the point of maximum concentration
- Chemicals are 100 percent bioavailable
- Maximum food ingestion rates were used (calculated maximum ingestion rates using allometric equations were based on the maximum adult body weight)
- Minimum adult body weights were used. The selection focused on the most geographically appropriate values available from standard literature sources (such as USEPA, 1993).

For the baseline (Step 3A) estimates:

- Central tendency estimates (such as mean, median, or midpoint) for adult body weight and ingestion rates were used. Central tendency estimates for these exposure parameters are more relevant for a BERA because they better represent the characteristics of a greater proportion of the individuals in the population. Populations or communities (rather than individual organisms) were emphasized when developing the assessment endpoints for the BERA.

An AUF of 1.0 was retained in the BERA.

## J.4 Effects Assessment

One of the purpose of the effects assessment is to establish chemical exposure levels (ESVs) that represent conservative thresholds for adverse ecological effects. Typically, one set of ESVs is developed for each selected assessment endpoint. Based on the CSM, direct exposure to surface soil and shallow subsurface soil, exposure via terrestrial food webs, and indirect exposure to groundwater are the complete pathways at the site that are relevant to this RI.

The effects assessment defines the methods and data used to define an adverse ecological effect. Effects data are available from multiple lines of evidence, which are reflected in the measurement endpoints, and include:

- **ESVs for Surface Water and Soil** – Analytical data (groundwater and soil) are compared to the literature-based, medium-specific ESVs developed in **Section J.4.1**.
- **Toxicity Reference Values (TRVs) for Ingestion Exposures** – Food web exposure estimates are compared to the ingestion-based TRVs developed in **Section J.4.2** for upper trophic level receptors.
- **Bioavailability Measures** - Additional data were collected to help evaluate chemical-specific bioavailability in abiotic media.

In addition, a comparison of site soil concentrations to facility background soil concentrations, and site groundwater concentrations to site-specific background (upgradient) groundwater concentrations, was conducted as an additional line of evidence (see **Sections J.5.3 and J.5.4**).

### J.4.1 Medium-Specific ESVs

Medium-specific ESVs were established for each ecologically relevant medium. Based on the CSM (**Figure J-1**), direct exposure to surface and shallow subsurface soil, and indirect exposure to groundwater, are the potentially complete pathways relevant to this RI.

#### J.4.1.1 Soil ESVs

The soil ESVs used in the ERA are summarized in **Table J-13**. When more than one ESV was available (such as fauna and flora) from a particular source for a chemical, the lowest of these values was selected.

#### J.4.1.2 Surface Water ESVs

Penniman Lake is a fresh water body but King Creek is a tidal estuarine water body (salinity measured in King Creek near the Penniman Lake dam exceeded 10 ppt) so both freshwater and marine ESVs were used for the groundwater comparisons. The surface water ESVs used in the ERA considered Region 3 BTAG screening values (USEPA, 2006b) as well as other ESVs available from the literature. When more than one ESV was available (such as fauna and flora) from a particular source for a chemical, the lowest of these values was selected.

For surface water, the ESVs for chemicals known to bioaccumulate in aquatic food webs were based on the final chronic value (rather than the final residue value) as per USEPA (1996b, 2009) and Suter and Tsao (1996). The use of final chronic values is intended to protect aquatic receptors from direct exposures to chemicals in surface water, rather than from exposure via food webs.

Fresh surface water ESVs for several divalent metals require site-specific adjustment based on water hardness. Hardness was not measured in groundwater samples so the default hardness (100 mg/L) was used. For metals, both unfiltered (total) and filtered (dissolved) concentrations were included in the ESV comparison. The surface water ESVs used in the ERA for groundwater are listed in **Table J-14**.

### J.4.2 Ingestion TRVs

Ingestion TRVs for dietary exposures were derived for each bioaccumulative chemical evaluated in the ERA. TRVs were derived for mammalian and avian upper trophic level receptors, the only two taxonomic groups for which sufficient toxicological information was generally available for the range of bioaccumulative chemicals evaluated. Toxicological information from the literature for wildlife species most closely related to the receptor species were used, where available, but were supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary. The ingestion TRVs are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Survival, growth, and reproduction were emphasized as toxicological endpoints because they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied toxicological endpoints for ecological receptors. Endpoints based on reproduction were generally preferred to those based on growth which were preferred to those based on survival. If several chronic toxicological studies were available from the literature, the most appropriate study was selected for each receptor based on study design, study methodology, study duration, study endpoint, and test species.

Ingestion TRVs were derived for both chronic No Observed Adverse Effect Level (NOAEL) and chronic Lowest Observed Effect Level (LOAEL) endpoints. The applicable uncertainty factors from **Table J-15** were used to derive these TRVs where appropriate (uncertainty factors were not generally applied to TRVs obtained from

Eco-SSL documents because these TRVs often encompassed multiple studies). Because assessment endpoints were based on population- or community-level effects, no intraspecies uncertainty factors were applied. Taxonomic class-type uncertainty factors were also not applied because the TRVs selected were typically derived based on data from a broad range of taxonomic groups. Maximum Acceptable Toxicant Concentrations (MATCs), defined as the geometric mean of the NOAEL and LOAEL, were also calculated.

In terrestrial habitats, Step 2 food web COPCs were selected by first comparing the maximum surface soil concentration with the lower of the available bird and mammal Eco-SSLs (**Table J-16**). Chemicals that exceeded the Eco-SSLs based on the maximum detected surface soil concentration were retained for site-specific food web modeling. Those that did not were not evaluated further for terrestrial food web exposures. The final Step 2 food web COPCs were selected based on a comparison of maximum exposure doses from site-specific food web modeling with the NOAEL-based ingestion TRV. Those chemicals with an exposure dose equaling or exceeding the NOAEL-based ingestion TRV were identified as Step 2 COPCs. For Step 3A, ingestion-based (food web) COPCs were based on a comparison of mean and 95% UCL exposure doses with ingestion TRVs based on the NOAEL, MATC, and LOAEL. Only Step 2 COPCs were evaluated in Step 3A. An exceedance of the MATC was generally considered an unacceptable effect at Step 3A, although chemicals that exceeded the MATC, but not the LOAEL, were discussed for possible risk management considerations.

Ingestion TRVs for mammals and birds are provided in **Tables J-17 and J-18**, respectively. For some chemicals, relevant toxicological information was available for more than one test species that represented different guilds (based on factors such as dietary composition and trophic level). In these instances, the TRV considered most applicable to the target wildlife receptor evaluated at the site was used in the food web model. **Tables J-17 and J-18** specifically indicate which test organism TRV was applied to each target wildlife receptor in the exposure dose calculations (see **Attachment J-1**).

### J.4.3 Bioavailability Measures

Data collected to evaluate the potential chemical-specific bioavailability in abiotic media included:

- **Soil** –TOC, pH, and grain size
- **Groundwater** – Dissolved metals

## J.5 Risk Characterization

The risk characterization portion of the ERA uses the information generated during the three previous parts of the ERA (problem formulation, exposure assessment, and effects assessment) to estimate potential risks to ecological receptors at the level of conservatism applied (screening or baseline).

### J.5.1 SERA Approach

The main objective of risk characterization at the screening level (termed risk calculation) is to derive a list of COPCs. As part of this risk calculation, the maximum exposure concentrations (abiotic media) or maximum exposure doses (upper trophic level receptors) are compared with the corresponding ESVs or TRVs to derive risk estimates using the hazard quotient (HQ) method. HQs are calculated by dividing the chemical concentration in the medium being evaluated by the corresponding medium-specific ESV or by dividing the exposure dose by the corresponding ingestion-based TRV. HQs equaling or exceeding 1 indicate the potential for unacceptable risk since the chemical concentration or dose (exposure) equals or exceeds the ESV or TRV (effect); these chemicals were identified as COPCs at Step 2. However, ESVs/TRVs and exposure estimates are derived using intentionally conservative assumptions at the screening level such that HQs greater than or equal to 1 do not necessarily indicate that unacceptable risks are present. Rather, it

identifies chemical-pathway-receptor combinations requiring further evaluation using less conservative (but more realistic) exposure scenarios and assumptions. HQs less than 1 indicate that unacceptable risks are unlikely, enabling a conclusion of negligible (acceptable) risk to be reached with high confidence.

In addition to chemicals that equaled or exceeded medium-specific ESVs based on maximum detected concentrations, or that equaled or exceeded TRVs based on maximum ingestion doses, the following also applied to COPC selection at Step 2:

- Non-detected chemicals were retained as COPCs if the maximum detection limit equaled or exceeded the ESV for that medium or if the ingestion dose calculated using the maximum detection limit equaled or exceeded the TRV
- All detected chemicals lacking a TRV and/or ESV were retained as COPCs
- The essential nutrients calcium, magnesium, potassium, and sodium were excluded as potential COPCs since they are essential macronutrients that are needed in relatively high concentrations for normal metabolism, growth, and reproduction

### J.5.2 BERA Approach

COPCs from the SERA were reevaluated in the BERA (Step 3A). As discussed previously, this reevaluation involves using less conservative (but more realistic) assumptions about exposures and a comparison of these revised exposure estimates (based on central tendency estimates of media concentrations, BAFs, and/or exposure parameters) with ESVs and TRVs.

In addition to chemicals that equaled or exceeded medium-specific ESVs based on mean and/or 95% UCL detected concentrations, or that equaled or exceeded TRVs based on mean and/or 95% UCL ingestion doses, the following also applied to COPC selection at Step 3A:

- All detected chemicals lacking a TRV and/or ESV were retained as COPCs for risk evaluation
- Ingestion-based (food web) COPCs were based on a comparison of mean and 95% UCL exposure doses with ingestion TRVs based on the NOAEL, MATC, and LOAEL. An exceedance of the MATC was generally considered an unacceptable risk at Step 3A, although chemicals that exceeded the MATC, but not the LOAEL, were discussed for possible risk management considerations. Exceedances of the LOAEL are almost always considered unacceptable and thus do not normally need to be discussed by the risk managers. Dose estimates that are less than the MATC are generally considered acceptable and also normally do not need to be discussed by the risk managers except in limited cases (such as when listed species are present). Thus, it is generally only those results between the MATC and LOAEL that risk managers need to decide are unacceptable or not.

For Step 3A, the following additional factors were also considered, as appropriate:

- **Frequency of Detection.** Frequency of detection was used as a line of evidence in Step 3A but was not used as the sole basis for eliminating a chemical from further evaluation. Chemicals that were detected in less than five percent of the samples in a medium were generally eliminated as COPCs in that medium if at least 20 samples were available (USEPA, 1989). It is unlikely that infrequently detected chemicals represent an unacceptable risk to receptors at the population level, due to limited spatial exposure. However, the magnitude of any ESV exceedances was also considered concurrently with frequency of detection to ensure that “hot spot” areas were not eliminated from consideration based on this screening criterion.

- **Background Concentrations.** Facility-specific background soil concentrations, and site-specific background (upgradient) groundwater concentrations, were also considered in Step 3A. The background evaluation consisted of a direct comparison of site soil concentrations to the soil 95% upper tolerance limits (UTLs) developed for inorganic constituents in the background study, and a direct comparison of site groundwater concentrations to the maximum concentration from upgradient groundwater wells, in a manner analogous to the comparison to ESVs. Soil background 95% UTL values have been developed separately for surface and subsurface soils (CH2M HILL, 2011).

### J.5.3 Terrestrial Habitats

Terrestrial habitats on the site are wooded. While the total size of the site is approximately 0.5 acres, the portion of the site associated with the former structures (sources areas) is very small, encompassing an area only about 2,000 square feet in size.

#### J.5.3.1 Comparison With Ecological Screening Values

As discussed in **Section J.3.2**, the maximum, arithmetic mean, and 95% UCL of the arithmetic mean concentrations were compared with ESVs. Chemicals were excluded from further consideration in the SERA (Step 2) if the HQ based on the maximum concentration was less than 1. Chemicals were generally excluded from further consideration in the BERA (Step 3A) if the HQ based on the 95% UCL was less than 1 and/or if the maximum detected concentration was less than the background UTL.

##### J.5.3.1.1 Surface Soil

Maximum surface soil concentrations are compared to soil ESVs for plants and soil invertebrates in **Table J-19**. **Table J-20** identifies the exceedances of ESVs and background UTLs for each surface soil sample. One explosive (2,4,6-trinitrotoluene [TNT]) and six metals (aluminum, iron, lead, mercury, selenium, and zinc) had HQs that equaled or exceeded 1 based on maximum detected concentrations (**Tables J-19 and J-20**). The ESVs for aluminum and iron were based on soil pH; soil pH data are reported in **Table J-1**. Four explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-nitrotoluene, and 3,5-dinitroaniline) were detected but soil ESVs were not available. These 10 chemicals were identified as Step 2 COPCs. Three SVOCs (4,6-dinitro-2-methylphenol, 4-nitrophenol, and atrazine) were not detected but maximum detection limits equaled or exceeded ESVs. These three chemicals were also identified as Step 2 COPCs.

One explosive (TNT) and two metals (lead and selenium) had HQs that equaled or exceeded 1 based on detected 95% UCL concentrations and also equaled or exceeded background UTLs (where available). These three chemicals were identified as Step 3A COPCs for further risk evaluation (**Section J.5.5**). Aluminum did not exceed both ESVs and background UTLs in any single sample (**Table J-20**). Iron exceeded both ESVs and UTLs in only one sample. However, the mean pH was within the acceptable range (as defined by the ESV) and the ratio to the background UTL for the single sample that exceeded both the ESV and UTL was less than 2. Thus, neither aluminum nor iron were identified as Step 3A COPCs for further risk evaluation. Four explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-nitrotoluene, and 3,5-dinitroaniline) were detected but soil ESVs were not available. These four chemicals were also identified as Step 3A COPCs for further risk evaluation.

Two SVOCs (4-nitrophenol and atrazine) were not detected but mean detection limits exceeded ESVs. These two chemicals were not identified as Step 3A COPCs for further risk evaluation but are evaluated further in the uncertainty section (**Section J.6**).

##### J.5.3.1.2 Shallow Subsurface Soil

Maximum subsurface soil concentrations are compared to soil ESVs for plants and soil invertebrates in **Table J-21**. **Table J-22** identifies the exceedances of ESVs and background UTLs for each subsurface soil

sample. Two explosives (2,4-dinitrotoluene and TNT) and six metals (aluminum, arsenic, hexavalent chromium [but not total chromium], iron, lead, and selenium) had HQs that equaled or exceeded 1 based on maximum detected concentrations (**Tables J-21 and J-22**). The ESVs for aluminum and iron were based on soil pH; soil pH data are reported in **Table J-1**. Four explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 4-nitrotoluene, and 3,5-dinitroaniline) were detected but soil ESVs were not available. These 12 chemicals were identified as Step 2 COPCs. Three SVOCs (4,6-dinitro-2-methylphenol, 4-nitrophenol, and atrazine) were not detected but maximum detection limits equaled or exceeded ESVs. These three chemicals were also identified as Step 2 COPCs.

One explosive (TNT) and three metals (hexavalent chromium, lead, and selenium) had HQs that equaled or exceeded 1 based on detected 95% UCL concentrations and also equaled or exceeded background UTLs (where available). These four chemicals were identified as Step 3A COPCs for further risk evaluation (**Section J.5.5**). Aluminum exceeded both ESVs and background UTLs in four samples (**Table J-22**). However, the maximum ratio to the background UTL for these four samples was only 1.15. Iron did not exceed both ESVs and UTLs in any single sample. Thus, neither aluminum nor iron were identified as Step 3A COPCs for further risk evaluation. Four explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 4-nitrotoluene, and 3,5-dinitroaniline) were detected but soil ESVs were not available. These four chemicals were also identified as Step 3A COPCs for further risk evaluation.

Two SVOCs (4-nitrophenol and atrazine) were not detected but mean detection limits exceeded ESVs. These two chemicals were not identified as Step 3A COPCs for further risk evaluation but are evaluated further in the uncertainty section (**Section J.6**).

### J.5.3.2 Terrestrial Food Web Exposures

In terrestrial habitats, Step 2 food web COPCs were selected by first comparing maximum surface soil concentrations with the lower of the available bird and mammal Eco-SSLs for the chemicals listed in **Table J-4**. These Eco-SSL values are listed in **Table J-16**. Chemicals that equaled or exceeded the Eco-SSLs based on the maximum surface soil concentration were retained for site-specific food web modeling. Those that did not were not evaluated further for terrestrial food web exposures. Chemicals that were on the bioaccumulative chemicals list (**Table J-4**) and did not have Eco-SSLs were automatically included in site-specific food web modeling. The final Step 2 food web COPCs were selected based on a comparison of maximum exposure doses from site-specific food web modeling with the NOAEL-based ingestion TRV. Those chemicals with an exposure dose equaling or exceeding the NOAEL-based ingestion TRV were identified as Step 2 COPCs. For Step 3A, ingestion-based (food web) COPCs were based on a comparison of mean and 95% UCL exposure doses with ingestion TRVs based on the NOAEL, MATC, and LOAEL. An exceedance of the 95% UCL-based MATC was generally considered an unacceptable risk at Step 3A.

**Table J-23** shows the results of the initial screening against bird and mammal Eco-SSLs. Four metals (chromium, lead, selenium, and zinc) and HMW PAHs had HQs based on maximum detected surface soil concentrations that equaled or exceeded 1 for one or both of the Eco-SSLs. These five chemicals were retained for site-specific food web modeling (see **Attachment J-1**).

HQs based on maximum exposure doses for each upper trophic level terrestrial receptor are listed in **Table J-24** (calculations are shown in **Attachment J-1**). Based on a comparison to NOAELs, four metals (chromium, lead, mercury, and selenium) had HQs equaling or exceeding 1 for one or more receptors. Ingestion TRVs were not available for any receptor for 4-bromophenyl-phenylether and 4-chlorophenyl-phenylether, neither of which was detected in surface soil.

HQs based on 95% UCL exposure doses for each upper trophic level terrestrial receptor are listed in **Table J-25** (calculations are shown in **Attachment J-1**). Based on a comparison to NOAELs, only lead had a

HQ that equaled or exceeded 1 for one or more receptors. HQs for lead based on the MATC and LOAEL also exceeded 1 for the short-tailed shrew and mourning dove.

HQs based on the arithmetic mean for each terrestrial upper trophic level receptor are listed in **Table J-26** (calculations are shown in **Attachment J-1**). Based on a comparison to NOAELs, there were no exceedances.

Based on these results, lead was identified as a Step 3A COPC for further risk evaluation.

### J.5.4 Aquatic Habitats

As discussed in **Section J.3.2**, the maximum, mean, and 95% UCL of the mean groundwater concentrations were compared with ESVs. Since site groundwater may potentially discharge to both Penniman Lake (freshwater) and King Creek (estuarine), both freshwater and marine ESVs were used for these comparisons. Chemicals were excluded from further consideration in the SERA if the HQ based on the maximum concentration was less than 1. Chemicals were excluded from further consideration in the BERA if the HQ based on the mean concentration was less than 1 (with dilution).

Although ecological receptors do not typically have direct exposure to groundwater, surface water ESVs were compared to site groundwater data (with and without dilution factors) in order to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to the water bodies (Penniman Lake/King Creek) located downgradient of the site. In the absence of site-specific dilution factors for groundwater, Buchman (1999) recommends using a dilution factor of 10 to account for the dilution expected during migration and upon discharge of groundwater to surface water.

Although both total and dissolved groundwater data were included in the screening tables, only dissolved metals data were used when selecting Step 3A COPCs for further risk evaluation because chemicals in groundwater are most likely to travel dissolved in water rather than adhered to particles since they must travel through soil pores or fractured rock. Similarly, when groundwater discharges to a water body (at which time ecological exposures become possible), the bulk of the discharged chemicals are likely to be dissolved in water since the discharge must pass through the pores in the underlying sediments. Thus, the dissolved concentrations are likely to be more representative of what would be transported via the groundwater than the total concentrations. Once discharged, the dissolved metal fraction in water (filtered samples) is more representative of the bioavailable fraction to aquatic receptors than the total metal fraction (unfiltered samples) (USEPA, 1996b). This is reflected in how the most recent Ambient Water Quality Criteria have been developed for many metals, that is, they are based on the dissolved fraction (USEPA, 2009).

Based on freshwater ESVs, three metals (barium, iron, and manganese) and cyanide equaled or exceeded ESVs based on maximum detected concentrations in unfiltered samples collected from site monitoring wells (**Tables J-27 and J-28**). Each of the three metals also equaled or exceeded ESVs based on maximum detected concentrations in filtered samples. Thus, barium, iron, manganese, and cyanide were identified as Step 2 COPCs.

Based on marine ESVs, manganese and cyanide equaled or exceeded ESVs based on maximum detected concentrations in unfiltered samples collected from site monitoring wells (**Tables J-27 and J-28**). Manganese also equaled or exceeded ESVs based on maximum detected concentrations in filtered samples. Aluminum, cobalt, and iron were detected but lacked marine ESVs. Thus, manganese, cyanide, aluminum, cobalt, and iron were identified as Step 2 COPCs.

Maximum detected site concentrations of the Step 2 COPCs are compared with maximum site-specific background (upgradient) groundwater concentrations (**Table J-29**) in **Table J-27**. Only barium and iron (both total and dissolved) equaled or exceeded maximum background concentrations. Cyanide was not detected

in upgradient wells. The mean site concentrations of cyanide, dissolved barium, and dissolved iron in groundwater were then compared with ESVs (**Table J-27**). For barium, the mean concentrations exceeded both the freshwater and marine ESVs. For iron, the mean concentrations exceeded the freshwater ESV (iron lacked a marine ESV). The mean concentration of cyanide was slightly higher than its freshwater ESV and also exceeded the marine ESV. Thus, barium, iron, and cyanide were identified as Step 3A COPCs for further risk evaluation. No undetected chemical had a mean detection limit that exceeded its ESV.

## J.5.5 Risk Evaluation

In this section, the various lines of evidence discussed in the previous section are integrated in order to evaluate the potential for unacceptable risks.

### J.5.5.1 Terrestrial Habitats

Ten assessment endpoints were developed for terrestrial habitats on the site (**Table J-3**). Lines of evidence for terrestrial habitats included:

- Comparison of surface soil and shallow subsurface soil concentrations with ESVs
- Comparison of modeled dietary doses with ingestion TRVs
- Comparison of site soil concentrations with background concentrations

In surface soil, two metals (lead and selenium) and five explosives (TNT, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-nitrotoluene, and 3,5-dinitroaniline) were identified as Step 3A COPCs for further risk evaluation (**Table J-19**). Lead was also identified as a Step 3A COPC for further risk evaluation for terrestrial food web exposures. TNT is the primary risk driver based on the magnitude of the ESV exceedances but the extent of the exceedances is spatially limited. The highest TNT concentrations in surface soil occur in the composite sample from the former TNT Catch Box (SO-26). The other exceedances occur directly adjacent to the former TNT Catch Box to the east and south (SS-01, SS-13, and SS-36) and in the vicinity of the former sump (SS-38 and SS-02). There were no detections of the other four explosive COPCs (which lacked ESVs) in any sample that did not also have an exceedance of the TNT ESV (**Table J-20**). Similarly, the two highest concentrations of lead in surface soil occurred in the two samples with the highest TNT concentrations. Thus, spatially limited risks associated with lead may occur for lower trophic level receptors. Although the 95% UCL concentration of lead in surface soil resulted in HQs in excess of 1 based on the MATC for the shrew and mourning dove, there were no exceedances based on the mean concentration. Thus, given the very limited spatial area with elevated lead concentrations, potential risks for upper trophic level receptors from food web exposures are likely to be low. Selenium exceeded ESVs and background UTLs in only two surface soil samples and did not follow the spatial pattern of lead and TNT. The 95% UCL HQ was just over 1 (1.05). Thus, potential risks associated with selenium are low and do not appear to be site related. In summary, TNT and lead are the primary risk drivers in surface soil but the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas.

In shallow subsurface soil, three metals (hexavalent chromium, lead, and selenium) and five explosives (TNT, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 4-nitrotoluene, and 3,5-dinitroaniline) were identified as COPCs for further risk evaluation (**Table J-21**). TNT is the primary risk driver based on the magnitude of the ESV exceedances but, as for surface soil, the extent of the exceedances is spatially limited. The highest TNT concentrations in shallow subsurface soil occur in the composite sample from the former TNT Catch Box (SO-26). The other exceedances occur directly adjacent to the former TNT Catch Box to the east and south (SB-01, SS-13, and SS-36) and in the vicinity of the former sump (SB-38). There were no detections of the other four explosive COPCs (which lacked ESVs) in any sample that did not also have an exceedance of the TNT ESV (**Table J-22**) except for SB-03, which had a low detection (28 µg/kg) of 1,3-dinitrobenzene. Similarly,

the highest concentration of lead in shallow subsurface soil (and the only ESV exceedance) occurred in the sample with the highest TNT concentration. Thus, spatially limited risks associated with lead may occur for lower trophic level receptors. Selenium exceeded background UTLs in only three shallow subsurface soil samples and did not follow the spatial pattern of lead and TNT. While the 95% UCL HQ was over 1 (1.62), the mean HQ did not exceed 1 (0.92). Thus, potential risks associated with selenium are low and do not appear to be site related. Although hexavalent chromium exceeded its ESV in a single sample, there were no ESV exceedances for total chromium and total chromium concentrations were at or below background levels. Thus, potential risks associated with chromium are not significant. In summary, TNT and lead are the primary risk drivers in shallow subsurface soil but, as for surface soils, the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas.

### **J.5.5.2 Aquatic Habitats**

Potential aquatic exposures in Penniman Lake adjacent to the AOC 6 TNT Subarea will be evaluated in the Penniman Lake RI. This ERA looked at the potential for off-site transport via groundwater to downgradient water bodies (Penniman Lake and King Creek). No chemical detected in site groundwater, except dissolved barium and dissolved iron, exceeded both its ESV and its background concentration. Dissolved iron exceeded its freshwater ESV (there was no marine ESV) by a factor of 27 based on the mean concentration. Thus, the mean HQ would exceed 1 even assuming a dilution factor of 10. The mean concentration of dissolved barium exceeded its freshwater (but not marine) ESV by a factor of less than 4. Thus, the mean HQ would be below 1 assuming a dilution factor of 10. However, the concentrations of dissolved barium and dissolved iron were not highly elevated relative to background concentrations, exceeding background in only 1 of the 4 site wells at maximum ratios of 1.73 and 1.23, respectively. The one background exceedance for barium was in MW-04, located south of Garrison Road near King Creek. King Creek is an estuarine water body and dissolved barium did not exceed its marine ESV. Thus, these two metals do not appear to be site related (neither was a COPC in site soils) nor do they appear to be present at concentrations that would present a potential risk to aquatic receptors above background levels.

Cyanide also exceeded both its freshwater and marine ESV in one sample (MW-05). The ESVs for cyanide are based on free (bioavailable) cyanide, not total cyanide, while the measured groundwater concentrations are for total cyanide. Only a small fraction of the total cyanide will be present in bioavailable forms. The mean HQ (undiluted) was slightly greater than 1 (1.04) based on the freshwater ESV and exceeded 1 (5.40) based on the marine ESV. Assuming a dilution factor of 10, the mean HQ is below 1 even if it is assumed that all of the cyanide is present in bioavailable forms. Cyanide was not a soil COPC and does not appear to be site related.

Based on the results of this evaluation, groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.

## **J.6 Uncertainties**

Uncertainties are present in all ERAs because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. In addition, the use of various models (such as uptake and food web exposures) carries with it some associated uncertainty as to how well the model reflects actual conditions. Since conservative assumptions were generally used in the exposure and effects assessments, these uncertainties are more likely to result in an overestimation rather than an underestimation of the likelihood and magnitude of risks to ecological receptors.

The ERA uses “standard” methods and typical ranges of values for EPCs (maximum, mean, and 95% UCL), TRVs (NOAEL, MATC, LOAEL), and other parameters. This results in risk estimates that adequately span the

risk range from extremely conservative (screening estimates) to central tendency (mean baseline estimates). The uncertainties associated with many of the particular inputs to the risk estimates are discussed below. What constitutes an unacceptable risk within this risk range is ultimately a risk management decision.

The uncertainties in this ERA are mainly attributable to the following factors:

- **Reporting Limits** – Reporting limits for some undetected analytes exceeded applicable ESVs in some media. **Table J-30** summarizes these chemicals, by medium, and reports both the ratio of the minimum and maximum reporting limits to the ESV as well as the ratio of the mean value (calculated using one-half of the reporting limit for each sample) to the ESV. Because these chemicals were not detected, they are not known to be present on the site but the potential for unacceptable risks cannot be totally discounted because the reporting limits are higher than the ESVs. The magnitude of the ratios can be used to qualitatively evaluate the magnitude of the associated uncertainty (that is, higher ratios are indicative of a greater likelihood that chemicals are present at concentrations that exceed the ESV relative to lower ratios). In both surface and shallow subsurface soils, only two undetected chemicals exceeded reporting limits based on the mean ratio, which exceeded 1.5 for only one of the two.

In summary, there were no chemicals with very high mean ratios, suggesting that the associated uncertainties are relatively low. Because standard analytical methods were used and the sample reporting limits were not elevated relative to the method reporting limits for the vast majority of samples and analytes, these uncertainties are considered acceptable and are unlikely to impact the conclusions of the ERA.

- **Duplicate Analyses** – When evaluating samples with field duplicates, the value used in the ERA was always the detect when one result was a detect and the duplicate was a non-detect, regardless of whether or not the non-detected value was higher. In these cases, the use of the detect has less uncertainty since it represents an actual measured value (versus an upper limit bound) and the two samples will have identical or similar reporting limits.
- **Selection of COPCs** – Chemicals without available ESVs for a medium were not retained as COPCs for risk evaluation unless they were detected. These uncertainties are unlikely to impact the conclusions of the ERA since these chemicals are not known to be present on the site.
- **Ingestion TRVs** – Data on the toxicity of many chemicals to the receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation and extrapolation for ERAs because so few wildlife species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet. It is difficult to predict if these extrapolations would result in overestimating or underestimating potential risks.

A second uncertainty related to the derivation of ingestion TRVs applies to metals. Most of the toxicological studies on which the ingestion TRVs for metals were based used forms of the metal (such as salts) that have high water solubility and high bioavailability to receptors. Because the analytical samples on which site-specific exposure estimates were based measured total metal concentration, regardless of form, and these highly bioavailable forms are expected to compose only a fraction of the total metal concentration, this is likely to result in an overestimation of potential risks for these chemicals but not to the extent that it would unduly impact the conclusions of the ERA.

A third source of uncertainty related to the derivation of ingestion-based TRVs applies to mercury and selenium. The ingestion-based TRVs used for these two metals were based on organometallic (methylated) forms. TRVs for inorganic forms tend to be substantially higher. Given that inorganic forms likely contribute significantly to the total mercury and selenium, the use of TRVs based on organometallic forms tends to make the TRVs for these metals extremely conservative and likely overestimates potential risk.

- Chemical Mixtures – Information on the toxicological effects of chemical interactions is generally lacking for ecological receptors, which required (as is standard for ERAs) that the chemicals be evaluated on a compound-by-compound basis during the comparison to ESVs and TRVs. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).
- Receptor Species Selection – Amphibians and reptiles were selected as receptors in the ERA, but were not evaluated quantitatively even when exposure pathways were likely to be complete. For food web exposures, these taxa were evaluated using other fauna (birds and mammals) as surrogates due to the general lack of taxon-specific toxicological data. This represents an uncertainty in the ERA. It was also assumed that any reptiles and amphibians present on the site were not exposed to significantly higher concentrations of chemicals and were not more sensitive to chemicals than other receptor species evaluated in the ERA that were used as surrogates for these groups. This assumption was a source of uncertainty in the ERA. In addition, there is some uncertainty associated with the use of specific receptor species to represent larger groups of organisms (such as guilds).
- Calculation of the Total Exposure Dose – For most chemicals, the contribution to the total dose from the inhalation route is insignificant for upper trophic level ecological receptors, especially relative to ingestion pathways. Thus, and given the general lack of data for evaluating this pathway (USEPA, 1999), the air pathway is not generally included in the total dose calculations for these ecological receptors. This could lead to an underestimation of the total dose to which these receptors are exposed. However, this underestimation is likely to be very small since volatile organic compounds (the constituents most likely to contribute to exposures via the inhalation route) are not known site constituents. Exposure to chemicals present in surface soil via dermal contact may occur but is unlikely to represent a major exposure pathway for most upper trophic level receptors because fur or feathers minimize transfer of chemicals across dermal tissue. As for the inhalation pathway, there is a general lack of data for evaluating this pathway (USEPA, 1999) and not including this pathway in the calculation of the total dose is not likely to significantly underestimate total exposure, especially since incidental ingestion of surface soil during feeding, preening, or grooming activities is included in the total dose calculations.
- Food Web Exposure Modeling – Chemical concentrations in terrestrial food items (terrestrial plants, soil invertebrates, and small mammals) were modeled from measured surface soil concentrations and were not directly measured. The use of generic, literature-derived exposure models and BAFs introduces some uncertainty into the resulting estimates. The values selected and methodology employed were intended to provide a conservative (Step 2) or reasonable (Step 3A) estimate of potential food web exposure concentrations.

Another source of uncertainty is the use of default assumptions for exposure parameters such as BCFs and BAFs. Although BCFs or BAFs for many bioaccumulative chemicals were readily available from the literature and were used in the ERA, the use of a default factor of 1.0 to estimate the concentration of some chemicals in receptor prey items is a source of uncertainty.

AUFs were assumed to equal 1. This is a very conservative assumption given the small size of the site (about 0.5 acres) since a significant percentage of each upper trophic level receptor species' time could

be spent foraging off-site in unimpacted areas or in areas where chemical concentrations are expected to be significantly lower.

- Mean Versus Maximum Media Concentrations – As is typical in an ERA, a finite number of samples of environmental media were used to develop the exposure estimates. The maximum concentration provides a conservative estimate of risk for immobile biota or those with a limited home range. The most realistic exposure estimates for mobile upper trophic level species with relatively large home ranges are those based on central tendency estimates of chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the *Wildlife Exposure Factors Handbook* (USEPA, 1993), which specify the calculation of an average daily dose. Given the mobility of the upper trophic level receptor species used in the ERA, the use of maximum chemical concentrations (rather than 95% UCL and mean concentrations) in the SERA (Step 2) to estimate the exposure via food webs is very conservative. This conservatism was reduced to more realistic levels in the values selected for use in the BERA (Step 3A) food web evaluation.

In cases where adequate spatial sampling coverage exists, central tendency estimates of chemical concentrations in exposure media are also appropriate for evaluating potential risks to populations of lower trophic level receptors because the members of the population are expected to be found throughout a site (where suitable habitat is present), rather than concentrated in one particular area. While effects on individual organisms might be important for some receptors, such as rare and endangered species, population- and community-level effects are typically more relevant to ecosystems. The 95% UCL of the arithmetic mean was typically used quantitatively in the BERA portion of this ERA to represent the average exposure scenarios during COPC selection.

- Comparisons to Background Concentrations – Background concentrations were used to judge the site-relatedness of individual chemicals. If site concentrations were consistent with background levels, it was assumed that the concentrations were not related to known site-related source areas. There exists the possibility that concentrations below background were indeed site-related, rendering the assumption false. However, the potential impact of this possibility is minimal since chemicals at concentrations consistent with background should exhibit no different ecological effects than commonly occurring in areas not affected by releases, regardless of their source.
- Total Versus Dissolved Metals – USEPA guidance (USEPA, 1996b) indicates that the dissolved metal fraction should be preferentially used to the total metal fraction in surface water (and by extension, groundwater) screening. Although both total and dissolved groundwater data were included in the screening tables, only dissolved metals data were used when selecting Step 3A COPCs for further risk evaluation because chemicals in groundwater are most likely to travel dissolved in water rather than adhered to particles since they must travel through soil pores or fractured rock. Similarly, when groundwater discharges to a water body (at which time ecological exposures become possible), the bulk of the discharged chemicals are likely to be dissolved in water since the discharge must pass through the pores in the underlying sediments. Thus, the dissolved concentrations are likely to be more representative of what would be transported via the groundwater than the total concentrations. Once discharged, the dissolved metal fraction in water (filtered samples) is more representative of the bioavailable fraction to aquatic receptors than the total metal fraction (unfiltered samples) (USEPA, 1996b). This is reflected in how the most recent Ambient Water Quality Criteria have been developed for many metals, that is, they are based on the dissolved fraction (USEPA, 2009).
- Evaluation of the Groundwater Transport Pathway – Potential ecological risks from groundwater discharge to downgradient surface water bodies (Penniman Lake and King Creek) were indirectly evaluated through a comparison of groundwater concentrations from site wells with surface water ESVs.

Surface water, pore water, and/or sediment samples were not collected from this water body as part of this investigation. The direct screening of groundwater data is normally the first step in such an evaluation (e.g., USEPA, 2008b), with surface water, pore water, and/or sediment samples only collected from the receiving water body or bodies if the initial screening indicates the potential for significant transport and exposure from this pathway. Based on the results of the groundwater screening, potential site-related ecological risks were not high enough to warrant further evaluation or sample collection in the receiving water bodies.

## J.7 Risk Summary and Conclusions

In summary, TNT and lead are the primary risk drivers in surface and shallow subsurface soils (**Table J-31**) but the locations with high concentrations are limited to the known source areas and/or the immediately adjacent areas. Based on the results of this evaluation, groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.

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Table J-1

## Physical Parameter Measurements - AOC 6 TNT Subarea Soil

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	Sample ID	Date	Depth (inches)	Total Organic Carbon		pH	Grain Size (percent)				
				mg/kg	percent		Gravel	Coarse Sand	Medium Sand	Fine Sand	Fines
Surface Soil											
CAA06-SO01	CAA06-SS01-1008	10/20/2008	0-6	120,000	12.0	4.60	NS	NS	NS	NS	NS
CAA06-SO02	CAA06-SS02-1008	10/21/2008	0-6	7,300	0.73	6.80	NS	NS	NS	NS	NS
CAA06-SO03	CAA06-SS03-1008	10/21/2008	0-6	6,200	0.62	7.10	NS	NS	NS	NS	NS
CAA06-SO04	CAA06-SS04-1008	10/21/2008	0-6	27,000	2.70	7.10	NS	NS	NS	NS	NS
CAA06-SO07	CAA06-SS07-1108	11/5/2008	0-6	22,000	2.20	5.40	NS	NS	NS	NS	NS
CAA06-SO08	CAA06-SS08-1108	11/6/2008	0-6	49,000	4.90	5.00	NS	NS	NS	NS	NS
CAA06-SO13	CAA06-SS13-1108	11/6/2008	0-6	30,000	3.00	5.00	NS	NS	NS	NS	NS
CAA06-SO26	CAA06-SO26-000H-0913	9/19/2013	0-6	120,000	12.0	5.70	3.2	8.2	38.1	42.3	8.2
CAA06-SO26	CAA06-SS26-0913	9/19/2013	0-6	NS	NS	NS	NS	NS	NS	NS	NS
CAA06-SO27	CAA06-SS27-0913	9/18/2013	0-6	NS	NS	NS	NS	NS	NS	NS	NS
CAA06-SO28	CAA06-SS28-0913	9/18/2013	0-6	15,000	1.50	4.90	0.7	9.7	39.6	38.7	11.3
CAA06-SO29	CAA06-SS29-0913	9/18/2013	0-6	22,000	2.20	4.80	0.5	2.0	42.4	46.7	8.4
CAA06-SO30	CAA06-SS30-0913	9/18/2013	0-6	10,000	1.00	4.40	1.7	1.8	27.0	49.6	19.9
CAA06-SO31	CAA06-SS31-0913	9/18/2013	0-6	12,000	1.20	4.60	0.1	0.3	19.9	53.0	26.7
CAA06-SO32	CAA06-SS32-0913	9/18/2013	0-6	11,000	1.10	5.00	0.1	0.3	17.8	56.1	25.7
CAA06-SO33	CAA06-SS33-0913	9/18/2013	0-6	25,000	2.50	5.20	2.6	1.2	22.7	53.9	19.6
CAA06-MW01	CAA06-SS34-0913	9/17/2013	0-6	8,000	0.80	5.40	0.1	0.3	33.0	51.4	15.2
CAA06-MW02	CAA06-SS35-0913	9/17/2013	0-6	12,000	1.20	5.10	0.3	3.9	43.7	43.4	8.7
CAA06-MW03	CAA06-SS36-0913	9/17/2013	0-6	17,000	1.70	4.60	0.9	2.6	30.2	50.0	16.3
CAA06-MW04	CAA06-SS37-0913	9/17/2013	0-6	65,000	6.50	4.10	1.1	0.9	19.6	56.1	22.3
CAA06-MW05	CAA06-SS38-0913	9/17/2013	0-6	20,000	2.00	4.40	0.4	1.4	24.3	54.5	19.4
CAA06-SO39	CAA06-SS39-0913	9/17/2013	0-6	19,000	1.90	4.80	0.4	1.0	20.7	56.1	21.8
Subsurface Soil											
CAA06-SO01	CAA06-SB01-1008	10/20/2008	6-24	2,600	0.26	6.00	NS	NS	NS	NS	NS
CAA06-SO02	CAA06-SB02-1008	10/21/2008	6-24	3,200	0.32	5.70	NS	NS	NS	NS	NS
CAA06-SO03	CAA06-SB03-1008	10/21/2008	6-24	2,200	0.22	6.10	NS	NS	NS	NS	NS
CAA06-SO04	CAA06-SB04-1008	10/21/2008	6-24	2,500	0.25	6.10	NS	NS	NS	NS	NS
CAA06-SO07	CAA06-SB07-1108	11/5/2008	6-24	4,700	0.47	5.80	NS	NS	NS	NS	NS

Table J-1

## Physical Parameter Measurements - AOC 6 TNT Subarea Soil

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	Sample ID	Date	Depth (inches)	Total Organic Carbon		pH	Grain Size (percent)				
				mg/kg	percent		Gravel	Coarse Sand	Medium Sand	Fine Sand	Fines
CAA06-SO08	CAA06-SB08-1108	11/6/2008	6-24	12,000	1.20	6.80	NS	NS	NS	NS	NS
CAA06-SO13	CAA06-SB13-1108	11/6/2008	6-24	5,600	0.56	5.30	NS	NS	NS	NS	NS
CAA06-SO26	CAA06-SO26-0H02-0913	9/19/2013	6-24	22,000	2.20	5.70	NS	NS	NS	NS	NS
CAA06-SO27	CAA06-SB27-0H02-0913	9/18/2013	6-24	NS	NS	NS	NS	NS	NS	NS	NS
CAA06-SO28	CAA06-SB28-0H02-0913	9/18/2013	6-24	4,100	0.41	5.10	NS	NS	NS	NS	NS
CAA06-SO29	CAA06-SB29-0H02-0913	9/18/2013	6-24	17,000	1.70	4.80	NS	NS	NS	NS	NS
CAA06-SO30	CAA06-SB30-0H02-0913	9/18/2013	6-24	6,000	0.60	4.50	NS	NS	NS	NS	NS
CAA06-SO31	CAA06-SB31-0H02-0913	9/18/2013	6-24	5,600	0.56	5.10	NS	NS	NS	NS	NS
CAA06-SO32	CAA06-SB32-0H02-0913	9/18/2013	6-24	5,900	0.59	5.20	NS	NS	NS	NS	NS
CAA06-SO33	CAA06-SB33-0H02-0913	9/18/2013	6-24	5,900	0.59	5.40	NS	NS	NS	NS	NS
CAA06-MW01	CAA06-SB34-0H02-0913	9/17/2013	6-24	1,200	0.12	5.70	NS	NS	NS	NS	NS
CAA06-MW02	CAA06-SB35-0H02-0913	9/17/2013	6-24	4,500	0.45	6.40	NS	NS	NS	NS	NS
CAA06-MW03	CAA06-SB36-0H02-0913	9/17/2013	6-24	7,700	0.77	4.30	NS	NS	NS	NS	NS
CAA06-MW04	CAA06-SB37-0H02-0913	9/17/2013	6-24	12,000	1.20	4.50	NS	NS	NS	NS	NS
CAA06-MW05	CAA06-SB38-0H02-0913	9/17/2013	6-24	6,800	0.68	5.20	NS	NS	NS	NS	NS
CAA06-SO39	CAA06-SB39-0H02-0913	9/17/2013	6-24	4,700	0.47	5.00	NS	NS	NS	NS	NS

NS - Not Sampled

Table J-2

## Samples Used in the AOC 6 TNT Subarea Ecological Risk Assessment

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	Sample ID	Date	Depth (inches)	Comment
<b>Surface Soil</b>				
CAA06-SO01	CAA06-SS01-1008	10/20/2008	0-6	
CAA06-SO02	CAA06-SS02-1008	10/21/2008	0-6	
CAA06-SO03	CAA06-SS03-1008	10/21/2008	0-6	
CAA06-SO04	CAA06-SS04-1008	10/21/2008	0-6	
CAA06-SO07	CAA06-SS07-1108	11/5/2008	0-6	
CAA06-SO08	CAA06-SS08-1108	11/6/2008	0-6	
CAA06-SO13	CAA06-SS13-1108	11/6/2008	0-6	
CAA06-SO26	CAA06-SS26-0913	9/19/2013	0-6	
CAA06-SO26	CAA06-SS26P-0913	9/19/2013	0-6	
CAA06-SO26	CAA06-SO26-000H-0913	9/19/2013	0-6	3-pt composite
CAA06-SO27	CAA06-SS27-0913	9/18/2013	0-6	
CAA06-SO28	CAA06-SS28-0913	9/18/2013	0-6	
CAA06-SO29	CAA06-SS29-0913	9/18/2013	0-6	
CAA06-SO30	CAA06-SS30-0913	9/18/2013	0-6	
CAA06-SO31	CAA06-SS31-0913	9/18/2013	0-6	
CAA06-SO32	CAA06-SS32-0913	9/18/2013	0-6	
CAA06-SO33	CAA06-SS33-0913	9/18/2013	0-6	
CAA06-MW01	CAA06-SS34-0913	9/17/2013	0-6	
CAA06-MW02	CAA06-SS35-0913	9/17/2013	0-6	
CAA06-MW02	CAA06-SS35P-0913	9/17/2013	0-6	
CAA06-MW03	CAA06-SS36-0913	9/17/2013	0-6	
CAA06-MW04	CAA06-SS37-0913	9/17/2013	0-6	
CAA06-MW05	CAA06-SS38-0913	9/17/2013	0-6	
CAA06-SO39	CAA06-SS39-0913	9/17/2013	0-6	
<b>Subsurface Soil</b>				
CAA06-SO01	CAA06-SB01-1008	10/20/2008	6-24	
CAA06-SO02	CAA06-SB02-1008	10/21/2008	6-24	
CAA06-SO03	CAA06-SB03-1008	10/21/2008	6-24	
CAA06-SO04	CAA06-SB04-1008	10/21/2008	6-24	
CAA06-SO07	CAA06-SB07-1108	11/5/2008	6-24	
CAA06-SO08	CAA06-SB08-1108	11/6/2008	6-24	
CAA06-SO13	CAA06-SB13-1108	11/6/2008	6-24	
CAA06-SO26	CAA06-SB26-0H02-0913	9/19/2013	6-24	
CAA06-SO26	CAA06-SB26P-0H02-0913	9/19/2013	6-24	
CAA06-SO26	CAA06-SO26-0H02-0913	9/19/2013	6-24	3-pt composite
CAA06-SO27	CAA06-SB27-0H02-0913	9/18/2013	6-24	
CAA06-SO28	CAA06-SB28-0H02-0913	9/18/2013	6-24	
CAA06-SO29	CAA06-SB29-0H02-0913	9/18/2013	6-24	
CAA06-SO30	CAA06-SB30-0H02-0913	9/18/2013	6-24	
CAA06-SO31	CAA06-SB31-0H02-0913	9/18/2013	6-24	
CAA06-SO32	CAA06-SB32-0H02-0913	9/18/2013	6-24	
CAA06-SO33	CAA06-SB33-0H02-0913	9/18/2013	6-24	
CAA06-MW01	CAA06-SB34-0H02-0913	9/17/2013	6-24	

Table J-2

## Samples Used in the AOC 6 TNT Subarea Ecological Risk Assessment

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Station ID	Sample ID	Date	Depth (inches)	Comment
CAA06-MW02	CAA06-SB35-0H02-0913	9/17/2013	6-24	
CAA06-MW02	CAA06-SB35P-0H02-0913	9/17/2013	6-24	
CAA06-MW03	CAA06-SB36-0H02-0913	9/17/2013	6-24	
CAA06-MW04	CAA06-SB37-0H02-0913	9/17/2013	6-24	
CAA06-MW05	CAA06-SB38-0H02-0913	9/17/2013	6-24	
CAA06-SO39	CAA06-SB39-0H02-0913	9/17/2013	6-24	
Surface Water				
CAA06-SW01	CAA06-SW01-1008	10/23/2008	--	Used for drinking water exposures in terrestrial food web models
CAA06-SW01	CAA06-SW01P-1008	10/23/2008	--	
CAA06-SW02	CAA06-SW02-1008	10/23/2008	--	
Groundwater				
CAA06-MW01	CAA06-GW01-1013	10/2/2013	--	Upgradient Well
CAA06-MW01	CAA06-GW01P-1013	10/2/2013	--	Upgradient Well
CAA06-MW02	CAA06-GW02-1013	10/2/2013	--	Site Well
CAA06-MW03	CAA06-GW03-1013	10/2/2013	--	Site Well
CAA06-MW04	CAA06-GW04-1013	10/2/2013	--	Site Well
CAA06-MW05	CAA06-GW05-1013	10/2/2013	--	Site Well
CAA06-MW06	CAA06-GW06-1013	10/2/2013	--	Upgradient Well

Shaded cells indicate field duplicates

Table J-3

## Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
<b>Terrestrial Habitats</b>			
Survival, growth, and reproduction of terrestrial soil invertebrate communities	Are site-related chemical concentrations in surface soil sufficient to adversely affect soil invertebrate communities?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in surface soil with soil ESVs	Soil invertebrates
Survival, growth, and reproduction of terrestrial plant communities	Are site-related chemical concentrations in surface soil sufficient to adversely affect terrestrial plant communities?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in surface soil with soil ESVs	Terrestrial plants
Survival, growth, and reproduction of terrestrial reptile populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptile populations?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in surface soil with soil ESVs	Reptiles
		Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA (birds and mammals used as surrogates)	
Survival, growth, and reproduction of avian terrestrial herbivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume terrestrial plants (seeds) from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	Mourning dove
Survival, growth, and reproduction of avian terrestrial invertivore/omnivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume terrestrial plants and soil invertebrates from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	American robin
Survival, growth, and reproduction of avian terrestrial carnivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume small mammals from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	Red-tailed hawk
Survival, growth, and reproduction of mammalian terrestrial herbivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume plants from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	Meadow vole
Survival, growth, and reproduction of mammalian terrestrial invertivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume soil invertebrates from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	Short-tailed shrew

Table J-3

## Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian terrestrial omnivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume terrestrial plants and soil invertebrates from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	White-footed mouse
Survival, growth, and reproduction of mammalian terrestrial carnivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume small mammals from the site?	Comparison of modeled dietary intakes using maximum (SERA) and mean (BERA) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based on the NOAEL-LOAEL range indicate an effect	Red fox
<b>Aquatic Habitats</b>			
Survival, growth, and reproduction of aquatic and wetland plant communities	Are site-related chemical concentrations in groundwater sufficient to adversely affect aquatic or wetland plant communities?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in groundwater with surface water ESVs	Aquatic and wetland plants
Survival, growth, and reproduction of aquatic and benthic invertebrate communities	Are site-related chemical concentrations in groundwater sufficient to adversely affect aquatic and benthic invertebrate communities?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in groundwater with surface water ESVs	Aquatic and benthic invertebrates
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in groundwater sufficient to adversely affect fish communities?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in groundwater with surface water ESVs	Fish
Survival, growth, and reproduction of amphibian populations	Are site-related chemical concentrations in groundwater sufficient to adversely affect amphibian populations?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in groundwater with surface water ESVs	Amphibians
Survival, growth, and reproduction of wetland/aquatic reptile populations	Are site-related chemical concentrations in groundwater sufficient to adversely affect aquatic/wetland reptile populations?	Comparison of maximum (SERA) and mean (BERA) chemical concentrations in groundwater with surface water ESVs	Reptiles

Table J-4

Bioaccumulative Chemicals List and Log K<sub>ow</sub> Values for Relevant Chemicals

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Log K <sub>ow</sub> Range	Selected log K <sub>ow</sub>	Reference
<b>Metals</b>			
Arsenic	-- - --	--	--
Cadmium	-- - --	--	--
Chromium <sup>1</sup>	-- - --	--	--
Copper	-- - --	--	--
Lead	-- - --	--	--
Mercury <sup>2</sup>	-- - --	--	--
Nickel	-- - --	--	--
Selenium	-- - --	--	--
Silver	-- - --	--	--
Zinc	-- - --	--	--
<b>Semivolatile Organic Compounds</b>			
4-Bromophenyl-phenylether	4.89 - 5.24	5.00	USEPA 1995a
4-Chlorophenyl-phenylether	4.08 - 5.09	4.95	USEPA 1995a
Acenaphthene	3.77 - 4.49	3.92	USEPA 1995a
Acenaphthylene	Not reported	4.10	USEPA 1996a
Anthracene	4.44 - 4.80	4.55	USEPA 1995a
Benzo(a)anthracene	5.61 - 5.79	5.70	USEPA 1995a
Benzo(a)pyrene	5.98 - 6.34	6.11	USEPA 1995a
Benzo(b)fluoranthene	5.79 - 6.40	6.20	USEPA 1995a
Benzo(g,h,i)perylene	6.58 - 7.05	6.70	USEPA 1995a
Benzo(k)fluoranthene	6.12 - 6.27	6.20	USEPA 1995a
Chrysene	5.41 - 5.79	5.70	USEPA 1995a
Dibenz(a,h)anthracene	6.50 - 6.88	6.69	USEPA 1995a
Fluoranthene	4.84 - 5.39	5.12	USEPA 1995a
Fluorene	4.04 - 4.40	4.21	USEPA 1995a
Hexachlorobenzene	5.23 - 6.92	5.89	USEPA 1995a
Hexachlorobutadiene	4.74 - 5.16	4.81	USEPA 1995a
Hexachlorocyclopentadiene	5.05 - 5.51	5.39	USEPA 1995a
Hexachloroethane	3.82 - 4.14	4.00	USEPA 1995a
Indeno(1,2,3-cd)pyrene	6.58 - 6.72	6.65	USEPA 1995a
Pentachlorophenol	5.01 - 5.24	5.09	USEPA 1995a
Phenanthrene	4.37 - 4.57	4.55	USEPA 1995a
Pyrene	4.76 - 5.52	5.11	USEPA 1995a

<sup>1</sup> Listed as chromium VI but applied to total chromium<sup>2</sup> Listed as methylmercury but applied to total mercury

Table J-5

## Soil Bioaccumulation Factors For Terrestrial Plants

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
<b>Metals</b>						
Arsenic	--	See Table J-6	--	--	See Table J-6	--
Cadmium	--	See Table J-6	--	--	See Table J-6	--
Chromium	0.084	90th percentile	Bechtel Jacobs 1998a	0.041	Median	Bechtel Jacobs 1998a; USEPA 2007h
Copper	--	See Table J-6	--	--	See Table J-6	--
Lead	--	See Table J-6	--	--	See Table J-6	--
Mercury	--	See Table J-6	--	--	See Table J-6	--
Nickel	--	See Table J-6	--	--	See Table J-6	--
Selenium	--	See Table J-6	--	--	See Table J-6	--
Silver	0.037	90th percentile	Bechtel Jacobs 1998a	0.014	Median	Bechtel Jacobs 1998a; USEPA 2007h
Zinc	--	See Table J-6	--	--	See Table J-6	--
<b>Semivolatile Organic Compounds</b>						
4-Bromophenyl-phenylether	0.566	Calculated	USEPA 2007h	0.566	Calculated	USEPA 2007h
4-Chlorophenyl-phenylether	0.593	Calculated	USEPA 2007h	0.593	Calculated	USEPA 2007h
Acenaphthene	--	See Table J-6	--	--	See Table J-6	--
Acenaphthylene	--	See Table J-6	--	--	See Table J-6	--
Anthracene	--	See Table J-6	--	--	See Table J-6	--
Benzo(a)anthracene	--	See Table J-6	--	--	See Table J-6	--
Benzo(a)pyrene	--	See Table J-6	--	--	See Table J-6	--
Benzo(b)fluoranthene	0.480	Maximum	USEPA 2007h	0.310	Median	USEPA 2007h
Benzo(g,h,i)perylene	--	See Table J-6	--	--	See Table J-6	--
Benzo(k)fluoranthene	--	See Table J-6	--	--	See Table J-6	--
Chrysene	--	See Table J-6	--	--	See Table J-6	--
Dibenz(a,h)anthracene	0.230	Maximum	USEPA 2007h	0.130	Median	USEPA 2007h
Fluoranthene	4.700	90th percentile	USEPA 2007h	0.500	Median	USEPA 2007h
Fluorene	--	See Table J-6	--	--	See Table J-6	--
Hexachlorobenzene	0.246	Calculated	USEPA 2007h	0.246	Calculated	USEPA 2007h
Hexachlorobutadiene	0.675	Calculated	USEPA 2007h	0.675	Calculated	USEPA 2007h

Table J-5

## Soil Bioaccumulation Factors For Terrestrial Plants

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
Hexachlorocyclopentadiene	0.393	Calculated	USEPA 2007h	0.393	Calculated	USEPA 2007h
Hexachloroethane	1.439	Calculated	USEPA 2007h	1.439	Calculated	USEPA 2007h
Indeno(1,2,3-cd)pyrene	0.150	Maximum	USEPA 2007h	0.110	Median	USEPA 2007h
Pentachlorophenol	30.10	90th percentile	USEPA 2007h	5.930	Median	USEPA 2007h
Phenanthrene	--	See Table J-6	--	--	See Table J-6	--
Pyrene	2.400	90th percentile	USEPA 2007h	0.720	Median	USEPA 2007h

<sup>1</sup> Calculated as described in the text using the "selected" log K<sub>ow</sub> from Table J-4

Table J-6

## Bioconcentration/Bioaccumulation Factor Models (Dry Weight)

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Plants <sup>1</sup>	Reference	Soil Invertebrates <sup>2</sup>	Reference
<b>Metals</b>				
Arsenic	$C_p = e^{(-1.992 + 0.564(\ln Cs))}$	Bechtel Jacobs 1998a	$C_w = e^{(-1.421 + 0.706(\ln Cs))}$	Sample et al. 1998a; USEPA 2007h
Cadmium	$C_p = e^{(-0.476 + 0.546(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	$C_w = e^{(2.114 + 0.795(\ln Cs))}$	Sample et al. 1998a; USEPA 2007h
Chromium	--	--	--	--
Copper	$C_p = e^{(0.669 + 0.394(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	$C_w = e^{(1.675 + 0.264(\ln Cs))}$	Sample et al. 1998a
Lead	$C_p = e^{(-1.328 + 0.561(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	$C_w = e^{(-2.218 + 0.807(\ln Cs))}$	Sample et al. 1998a; USEPA 2007h
Mercury	$C_p = e^{(-0.996 + 0.544(\ln Cs))}$	Bechtel Jacobs 1998a	--	--
Nickel	$C_p = e^{(-2.224 + 0.748(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	--	--
Selenium	$C_p = e^{(-0.678 + 1.104(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	$C_w = e^{(-0.075 + 0.733(\ln Cs))}$	Sample et al. 1998a; USEPA 2007h
Zinc	$C_p = e^{(1.575 + 0.555(\ln Cs))}$	Bechtel Jacobs 1998a; USEPA 2007h	$C_w = e^{(4.449 + 0.328(\ln Cs))}$	Sample et al. 1998a; USEPA 2007h
<b>PAHs</b>				
Acenaphthene	$C_p = e^{(-5.562 - 0.8556(\ln Cs))}$	USEPA 2007h	--	--
Acenaphthylene	$C_p = e^{(-1.144 + 0.791(\ln Cs))}$	USEPA 2007h	--	--
Anthracene	$C_p = e^{(-0.9887 + 0.7784(\ln Cs))}$	USEPA 2007h	--	--
Benzo(a)anthracene	$C_p = e^{(-2.7078 + 0.5944(\ln Cs))}$	USEPA 2007h	--	--
Benzo(a)pyrene	$C_p = e^{(-2.0615 + 0.9750(\ln Cs))}$	USEPA 2007h	--	--
Benzo(g,h,i)perylene	$C_p = e^{(-0.9313 + 1.1829(\ln Cs))}$	USEPA 2007h	--	--
Benzo(k)fluoranthene	$C_p = e^{(-2.1579 + 0.8595(\ln Cs))}$	USEPA 2007h	--	--

**Table J-6**

**Bioconcentration/Bioaccumulation Factor Models (Dry Weight)**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Plants <sup>1</sup>	Reference	Soil Invertebrates <sup>2</sup>	Reference
Chrysene	$C_p = e^{(-2.7078 + 0.5944(\ln C_s))}$	USEPA 2007h	--	--
Fluorene	$C_p = e^{(-5.562 - 0.8556(\ln C_s))}$	USEPA 2007h	--	--
Phenanthrene	$C_p = e^{(-0.1665 + 0.6203(\ln C_s))}$	USEPA 2007h	--	--

<sup>1</sup> Where  $C_p$  = Concentration in aboveground portion of plant (mg/kg dry wt) and  $C_s$  = Concentration in soil (mg/kg dry wt)

<sup>2</sup> Where  $C_w$  = Concentration in earthworm (mg/kg dry wt) and  $C_s$  = Concentration in soil (mg/kg dry wt)

**Table J-6**  
**Bioconcentration/Bioaccumulation Factor Models (Dry Weight)**  
**Remedial Investigation Report**  
*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Small Mammal Omnivores <sup>3</sup>	Reference	Small Mammal Herbivores <sup>3</sup>	Reference	Small Mammal Insectivores <sup>3</sup>	Reference
<b>Metals</b>						
Arsenic	$C_m = e^{(-4.5796 + 0.7354(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(-5.6531 + 1.1382(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(-4.8471 + 0.8188(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h
Cadmium	$C_m = e^{(-1.5383 + 0.5660(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(-1.2571 + 0.4723(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(0.8150 + 0.9638(\ln Cs))}$	Sample et al. 1998b
Chromium	$C_m = e^{(-1.4945 + 0.7326(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(-1.4599 + 0.7338(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-1.4599 + 0.7338(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h
Copper	$C_m = e^{(1.4592 + 0.2681(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(2.0420 + 0.1444(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(2.1042 + 0.1783(\ln Cs))}$	Sample et al. 1998b
Lead	$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-0.6114 + 0.5181(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(0.4819 + 0.4869(\ln Cs))}$	Sample et al. 1998b
Mercury	--	--	--	--	--	--
Nickel	$C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-0.2462 + 0.4658(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h
Selenium	$C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(-0.4158 + 0.3764(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h
Zinc	$C_m = e^{(4.4713 + 0.0738(\ln Cs))}$	Sample et al. 1998b	$C_m = e^{(4.3632 + 0.0706(\ln Cs))}$	Sample et al. 1998b; USEPA 2007h	$C_m = e^{(4.2479 + 0.1324(\ln Cs))}$	Sample et al. 1998b
<b>PAHs</b>						
Acenaphthene	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--

**Table J-6**

**Bioconcentration/Bioaccumulation Factor Models (Dry Weight)**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Small Mammal Omnivores <sup>3</sup>	Reference	Small Mammal Herbivores <sup>3</sup>	Reference	Small Mammal Insectivores <sup>3</sup>	Reference
Chrysene	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--

<sup>3</sup> Where C<sub>m</sub> = Concentration in whole-body small mammal (mg/kg dry wt) and C<sub>s</sub> = Concentration in soil (mg/kg dry wt)

Table J-7

## Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
<b>Metals</b>						
Arsenic	--	See Table J-6	--	--	See Table J-6	--
Cadmium	--	See Table J-6	--	--	See Table J-6	--
Chromium	3.162	90th percentile	Sample et al. 1998a	0.320	Geometric mean	Sample et al. 1998a
Copper	--	See Table J-6	--	--	See Table J-6	--
Lead	--	See Table J-6	--	--	See Table J-6	--
Mercury	20.63	90th percentile	Sample et al. 1998a	1.186	Geometric mean	Sample et al. 1998a
Nickel	4.730	90th percentile	Sample et al. 1998a	1.656	Arithmetic mean	Sample et al. 1998a
Selenium	--	See Table J-6	--	--	See Table J-6	--
Silver	15.34	90th percentile	Sample et al. 1998a	2.045	Median	Sample et al. 1998a
Zinc	--	See Table J-6	--	--	See Table J-6	--
<b>Semivolatile Organic Compounds</b>						
4-Bromophenyl-phenylether	1.000	Assumed	--	1.000	Assumed	--
4-Chlorophenyl-phenylether	1.000	Assumed	--	1.000	Assumed	--
Acenaphthene	0.300	Median	Beyer and Stafford 1993	0.300	Median	Beyer and Stafford 1993
Acenaphthylene	0.220	Median	Beyer and Stafford 1993	0.220	Median	Beyer and Stafford 1993
Anthracene	0.320	Median	Beyer and Stafford 1993	0.320	Median	Beyer and Stafford 1993
Benzo(a)anthracene	0.270	Median	Beyer and Stafford 1993	0.270	Median	Beyer and Stafford 1993
Benzo(a)pyrene	0.340	Median	Beyer and Stafford 1993	0.340	Median	Beyer and Stafford 1993
Benzo(b)fluoranthene	0.210	Median	Beyer and Stafford 1993	0.210	Median	Beyer and Stafford 1993
Benzo(g,h,i)perylene	0.150	Median	Beyer and Stafford 1993	0.150	Median	Beyer and Stafford 1993
Benzo(k)fluoranthene	0.210	Median	Beyer and Stafford 1993	0.210	Median	Beyer and Stafford 1993
Chrysene	0.440	Median	Beyer and Stafford 1993	0.440	Median	Beyer and Stafford 1993
Dibenz(a,h)anthracene	0.490	Median	Beyer and Stafford 1993	0.490	Median	Beyer and Stafford 1993
Fluoranthene	0.370	Median	Beyer and Stafford 1993	0.370	Median	Beyer and Stafford 1993
Fluorene	0.200	Median	Beyer and Stafford 1993	0.200	Median	Beyer and Stafford 1993
Hexachlorobenzene	1.690	Mean	Beyer 1996	1.690	Mean	Beyer 1996
Hexachlorobutadiene	1.000	Assumed	--	1.000	Assumed	--
Hexachlorocyclopentadiene	1.000	Assumed	--	1.000	Assumed	--
Hexachloroethane	1.000	Assumed	--	1.000	Assumed	--

**Table J-7**

**Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
Indeno(1,2,3-cd)pyrene	0.410	Median	Beyer and Stafford 1993	0.410	Median	Beyer and Stafford 1993
Pentachlorophenol	88.10	90th percentile	USEPA 2007h	14.63	Median	USEPA 2007h
Phenanthrene	0.280	Median	Beyer and Stafford 1993	0.280	Median	Beyer and Stafford 1993
Pyrene	0.390	Median	Beyer and Stafford 1993	0.390	Median	Beyer and Stafford 1993

**Table J-8**  
**Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores**  
**Remedial Investigation Report**  
*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
<b>Metals</b>						
Arsenic	--	See Table J-6	--	--	See Table J-6	--
Cadmium	--	See Table J-6	--	--	See Table J-6	--
Chromium	--	See Table J-6	--	--	See Table J-6	--
Copper	--	See Table J-6	--	--	See Table J-6	--
Lead	--	See Table J-6	--	--	See Table J-6	--
Mercury	0.130	90th percentile	Sample et al. 1998b	0.054	Median	Sample et al. 1998b
Nickel	--	See Table J-6	--	--	See Table J-6	--
Selenium	--	See Table J-6	--	--	See Table J-6	--
Silver	0.810	90th percentile	Sample et al. 1998b	0.151	Median	Sample et al. 1998b
Zinc	--	See Table J-6	--	--	See Table J-6	--
<b>Semivolatile Organic Compounds</b>						
4-Bromophenyl-phenylether	NA	--	--	NA	--	--
4-Chlorophenyl-phenylether	NA	--	--	NA	--	--
Acenaphthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Acenaphthylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(b)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(g,h,i)perylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(k)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Chrysene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Dibenz(a,h)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluorene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Hexachlorobenzene	NA	--	--	NA	--	--
Hexachlorobutadiene	NA	--	--	NA	--	--
Hexachlorocyclopentadiene	NA	--	--	NA	--	--
Hexachloroethane	NA	--	--	NA	--	--

**Table J-8**

**Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
Indeno(1,2,3-cd)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pentachlorophenol	NA	--	--	NA	--	--
Phenanthrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h

NA - Not Available (see text)

Table J-9

## Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Herbivores

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
<b>Metals</b>						
Arsenic	--	See Table J-6	--	--	See Table J-6	--
Cadmium	--	See Table J-6	--	--	See Table J-6	--
Chromium	--	See Table J-6	--	--	See Table J-6	--
Copper	--	See Table J-6	--	--	See Table J-6	--
Lead	--	See Table J-6	--	--	See Table J-6	--
Mercury	0.192	90th percentile	Sample et al. 1998b	0.067	Geometric mean	Sample et al. 1998b
Nickel	--	See Table J-6	--	--	See Table J-6	--
Selenium	--	See Table J-6	--	--	See Table J-6	--
Silver	0.007	90th percentile	Sample et al. 1998b	0.006	Geometric mean	Sample et al. 1998b
Zinc	--	See Table J-6	--	--	See Table J-6	--
<b>Semivolatile Organic Compounds</b>						
4-Bromophenyl-phenylether	NA	--	--	NA	--	--
4-Chlorophenyl-phenylether	NA	--	--	NA	--	--
Acenaphthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Acenaphthylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(b)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(g,h,i)perylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(k)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Chrysene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Dibenz(a,h)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluorene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Hexachlorobenzene	NA	--	--	NA	--	--
Hexachlorobutadiene	NA	--	--	NA	--	--
Hexachlorocyclopentadiene	NA	--	--	NA	--	--
Hexachloroethane	NA	--	--	NA	--	--

**Table J-9**

**Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Herbivores**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
Indeno(1,2,3-cd)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pentachlorophenol	NA	--	--	NA	--	--
Phenanthrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h

NA - Not Available (see text)

Table J-10

## Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
<b>Metals</b>						
Arsenic	--	See Table J-6	--	--	See Table J-6	--
Cadmium	--	See Table J-6	--	--	See Table J-6	--
Chromium	--	See Table J-6	--	--	See Table J-6	--
Copper	--	See Table J-6	--	--	See Table J-6	--
Lead	--	See Table J-6	--	--	See Table J-6	--
Mercury	0.192	90th percentile	Sample et al. 1998b	0.067	Geometric mean	Sample et al. 1998b
Nickel	--	See Table J-6	--	--	See Table J-6	--
Selenium	--	See Table J-6	--	--	See Table J-6	--
Silver	0.501	90th percentile	Sample et al. 1998b	0.036	Geometric mean	Sample et al. 1998b
Zinc	--	See Table J-6	--	--	See Table J-6	--
<b>Semivolatile Organic Compounds</b>						
4-Bromophenyl-phenylether	NA	--	--	NA	--	--
4-Chlorophenyl-phenylether	NA	--	--	NA	--	--
Acenaphthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Acenaphthylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(a)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(b)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(g,h,i)perylene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Benzo(k)fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Chrysene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Dibenz(a,h)anthracene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluoranthene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Fluorene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Hexachlorobenzene	NA	--	--	NA	--	--
Hexachlorobutadiene	NA	--	--	NA	--	--
Hexachlorocyclopentadiene	NA	--	--	NA	--	--
Hexachloroethane	NA	--	--	NA	--	--

**Table J-10**

**Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Insectivores**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Screening (Step 2)			Baseline (Step 3A)		
	Value	Basis	Reference	Value	Basis	Reference
Indeno(1,2,3-cd)pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pentachlorophenol	NA	--	--	NA	--	--
Phenanthrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h
Pyrene	0.000	Assumed	USEPA 2007h	0.000	Assumed	USEPA 2007h

NA - Not Available (see text)

Table J-11  
Exposure Parameters for Upper Trophic Level Ecological Receptors - Screening (Step 2)  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Receptor	Minimum Body Weight (kg)		Maximum Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (percent)						Soil Ingestion (percent)	
	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Terr Plants	Terr Invert	Mouse	Vole	Shrew	Reference	Value	Reference
Mammals																
Meadow vole	0.0300	Silva and Downing 1995	0.0635	Silva and Downing 1995	0.01334	USEPA 1993	0.00310	USEPA 1993	95.6	2.0	0.0	0.0	0.0	USEPA 1993	2.4	Beyer et al. 1994
Red fox	3.1700	Silva and Downing 1995	4.8700	Silva and Downing 1995	0.41154	allometric equation (USEPA 1993) <sup>1</sup>	0.14763	Sample and Suter 1994	7.0	2.8	29.2	29.1	29.1	USEPA 1993	2.8	Beyer et al. 1994
Short-tailed shrew	0.0133	USEPA 1993	0.02131	USEPA 1993	0.00475	USEPA 1993	0.00189	USEPA 1993	4.7	82.3	0.0	0.0	0.0	USEPA 1993; Sample and Suter 1994	13.0	Sample and Suter 1994
White-footed mouse	0.0141	Silva and Downing 1995	0.0305	Silva and Downing 1995	0.00915	Sample and Suter 1994	0.00073	Sample and Suter 1994	51.0	47.0	0.0	0.0	0.0	Martin et al. 1951; Sample and Suter 1994	2.0	Beyer et al. 1994
Birds																
American robin (omnivore)	0.0635	USEPA 1993	0.1030	USEPA 1993	0.01287	allometric equation (USEPA 1993) <sup>2</sup>	0.00736	Levey and Karasov 1989	51.9	43.5	0.0	0.0	0.0	Martin et al. 1951	4.6	Sample and Suter 1994
American robin (invertivore)	0.0635	USEPA 1993	0.1030	USEPA 1993	0.01287	allometric equation (USEPA 1993) <sup>2</sup>	0.00511	Levey and Karasov 1989	0.0	95.4	0.0	0.0	0.0	exclusive diet	4.6	Sample and Suter 1994
Mourning dove	0.1050	Tomlinson et al. 1994	0.1630	Tomlinson et al. 1994	0.01750	allometric equation (USEPA 1993) <sup>2</sup>	0.02090	allometric equation (Nagy 2001) <sup>3</sup>	95.0	0.0	0.0	0.0	0.0	Tomlinson et al. 1994	5.0	Assumed based on diet
Red-tailed hawk	0.9570	USEPA 1993	1.2350	USEPA 1993	0.06796	allometric equation (USEPA 1993) <sup>2</sup>	0.03952	Sample and Suter 1994	0.0	0.0	34.0	33.0	33.0	USEPA 1993; Sample and Suter 1994	0.0	Sample and Suter 1994

1 - All mammals equation:  $0.099 (BW)^{0.90}$  (maximum body weight used)  
2 - All birds equation:  $0.059 (BW)^{0.67}$  (maximum body weight used)  
3 - All birds equation:  $(0.638*((BW*1000)^{0.685}))/1000$  (maximum body weight used)

**Table J-12**  
**Exposure Parameters for Upper Trophic Level Ecological Receptors - Baseline (Step 3A)**  
**Remedial Investigation Report**  
*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)		Home Range (ha)		Dietary Composition (percent)						Soil Ingestion (percent)	
Mammals																
Meadow vole	0.0428	Silva and Downing 1995	0.00899	USEPA 1993	0.00209	USEPA 1993	0.013	USEPA 1993	95.6	2.0	0.0	0.0	0.0	USEPA 1993	2.4	Beyer et al. 1994
Red fox	4.0600	Silva and Downing 1995	0.34939	allometric equation (USEPA 1993) <sup>1</sup>	0.12308	Sample and Suter 1994	400	USEPA 1993	7.0	2.8	29.2	29.1	29.1	USEPA 1993	2.8	Beyer et al. 1994
Short-tailed shrew	0.0169	USEPA 1993	0.00376	USEPA 1993	0.00149	USEPA 1993	0.390	Sample and Suter 1994	4.7	82.3	0.0	0.0	0.0	USEPA 1993; Sample and Suter 1994	13.0	Sample and Suter 1994
White-footed mouse	0.0208	Silva and Downing 1995	0.00624	Sample and Suter 1994	0.00050	Sample and Suter 1994	0.059	Sample and Suter 1994	51.0	47.0	0.0	0.0	0.0	Martin et al. 1951; Sample and Suter 1994	2.0	Beyer et al. 1994
Birds																
American robin (omnivore)	0.0773	USEPA 1993	0.01062	allometric equation (USEPA 1993) <sup>2</sup>	0.00552	Levey and Karasov 1989	0.500	USEPA 1993 (foraging)	51.9	43.5	0.0	0.0	0.0	Martin et al. 1951	4.6	Sample and Suter 1994
American robin (invertivore)	0.0773	USEPA 1993	0.01062	allometric equation (USEPA 1993) <sup>2</sup>	0.00383	Levey and Karasov 1989	0.500	USEPA 1993 (foraging)	0.0	95.4	0.0	0.0	0.0	exclusive diet	4.6	Sample and Suter 1994
Mourning dove	0.1265	Tomlinson et al. 1994	0.01477	allometric equation (USEPA 1993) <sup>2</sup>	0.01757	allometric equation (Nagy 2001) <sup>3</sup>	956	Losito and Mirarchi 1991	95.0	0.0	0.0	0.0	0.0	Tomlinson et al. 1994	5.0	Assumed based on diet
Red-tailed hawk	1.1260	Sample and Suter 1994	0.06388	allometric equation (USEPA 1993) <sup>2</sup>	0.03603	Sample and Suter 1994	233	Sample and Suter 1994	0.0	0.0	34.0	33.0	33.0	USEPA 1993; Sample and Suter 1994	0.0	Sample and Suter 1994

1 - All mammals equation: 0.099 (BW)<sup>0.90</sup> (maximum body weight used)  
 2 - All birds equation: 0.059 (BW)<sup>0.67</sup> (maximum body weight used)  
 3 - All birds equation: (0.638\*((BW\*1000)<sup>0.685</sup>))/1000 (maximum body weight used)

Table J-13

## Ecological Screening Values (ESVs) for Soils - Plants and Soil Invertebrates

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	ESV	Units	Type/Receptor	Reference	Comments
Inorganics	Aluminum	pH < 5.5	--	Eco-SSL	USEPA 2003a	
Inorganics	Antimony	78.0	mg/kg	Eco-SSL - Invertebrate	USEPA 2005a	
Inorganics	Arsenic	18.0	mg/kg	Eco-SSL - Plant	USEPA 2005b	
Inorganics	Barium	330	mg/kg	Eco-SSL - Invertebrate	USEPA 2005c	
Inorganics	Beryllium	40.0	mg/kg	Eco-SSL - Invertebrate	USEPA 2005d	
Inorganics	Cadmium	32.0	mg/kg	Eco-SSL - Plant	USEPA 2005e	
Inorganics	Chromium (total)	64.0	mg/kg	Soil Quality Guideline	CCME 2007	
Inorganics	Chromium (hexavalent)	0.40	mg/kg	Soil Quality Guideline	CCME 2007	
Inorganics	Cobalt	13.0	mg/kg	Eco-SSL - Plant	USEPA 2005f	
Inorganics	Copper	70.0	mg/kg	Eco-SSL - Plant	USEPA 2007a	
Inorganics	Cyanide	15.8	mg/kg		MHSPE 2000	Geometric mean of target and intervention values (complex)
Inorganics	Iron	5 < pH > 8	--	Eco-SSL	USEPA 2003b	
Inorganics	Lead	120	mg/kg	Eco-SSL - Plant	USEPA 2005g	
Inorganics	Manganese	220	mg/kg	Eco-SSL - Plant	USEPA 2007b	
Inorganics	Mercury	0.10	mg/kg	Invertebrate	Efroymsen et al. 1997b	
Inorganics	Nickel	38.0	mg/kg	Eco-SSL - Plant	USEPA 2007c	
Inorganics	Selenium	0.52	mg/kg	Eco-SSL - Plant	USEPA 2007d	
Inorganics	Silver	560	mg/kg	Eco-SSL - Plant	USEPA 2006c	
Inorganics	Thallium	1.00	mg/kg	Plant	Efroymsen et al. 1997a	
Inorganics	Vanadium	130	mg/kg	Soil Quality Guideline	CCME 2007	
Inorganics	Zinc	120	mg/kg	Eco-SSL - Invertebrate	USEPA 2007e	
SVOCs	1,1-Biphenyl	13,600	ug/kg	Plant	Efroymsen et al. 1997a	EC50 (68,000); UF of 5
SVOCs	2,2'-Oxybis(1-chloropropane)	NSV	--		--	
SVOCs	2,4,5-Trichlorophenol	1,350	ug/kg	Plant	Efroymsen et al. 1997a	NOEC
SVOCs	2,4,6-Trichlorophenol	580	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 58,000; UF of 100
SVOCs	2,4-Dichlorophenol	500	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	2,4-Dimethylphenol	1,000	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	2,4-Dinitrophenol	20,000	ug/kg	Plant	Efroymsen et al. 1997a	NOEC
SVOCs	2,4-Dinitrotoluene	11,000	ug/kg	Plant/Invertebrate	NRCC 2006	
SVOCs	2,6-Dinitrotoluene	8,500	ug/kg	Plant/Invertebrate	NRCC 2006	

Table J-13

## Ecological Screening Values (ESVs) for Soils - Plants and Soil Invertebrates

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	ESV	Units	Type/Receptor	Reference	Comments
SVOCs	2-Chloronaphthalene	LMW PAH	--		--	
SVOCs	2-Chlorophenol	500	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	2-Methylnaphthalene	LMW PAH	--		--	
SVOCs	2-Methylphenol	1,000	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	2-Nitroaniline	NSV	--		--	
SVOCs	2-Nitrophenol	1,000	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	3,3'-Dichlorobenzidine	NSV	--		--	
SVOCs	3-Nitroaniline	NSV	--		--	
SVOCs	4,6-Dinitro-2-methylphenol	1,000	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	4-Bromophenyl-phenylether	NSV	--		--	
SVOCs	4-Chloro-3-methylphenol	500	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	4-Chloroaniline	500	ug/kg		MHSPE 2000	Geometric mean of target and intervention values
SVOCs	4-Chlorophenyl-phenylether	NSV	--		--	
SVOCs	4-Methylphenol	1,000	ug/kg		Beyer 1990; CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland; B value ("moderate soil contamination")
SVOCs	4-Nitroaniline	NSV	--		--	
SVOCs	4-Nitrophenol	380	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 38,000; UF of 100
SVOCs	Acenaphthene	LMW PAH	--		--	
SVOCs	Acenaphthylene	LMW PAH	--		--	
SVOCs	Acetophenone	NSV	--		--	
SVOCs	Anthracene	LMW PAH	--		--	
SVOCs	Atrazine	11.9	ug/kg		MHSPE 2000; 2001	Geometric mean of target and SRC values
SVOCs	Benzaldehyde	58,400	ug/kg	Plant	Hulzebos et al. 1993	EC50 of 292,000; UF of 5
SVOCs	Benzo(a)anthracene	HMW PAH	--		--	
SVOCs	Benzo(a)pyrene	HMW PAH	--		--	
SVOCs	Benzo(b)fluoranthene	HMW PAH	--		--	
SVOCs	Benzo(g,h,i)perylene	HMW PAH	--		--	

Table J-13

## Ecological Screening Values (ESVs) for Soils - Plants and Soil Invertebrates

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	ESV	Units	Type/Receptor	Reference	Comments
SVOCs	Benzo(k)fluoranthene	HMW PAH	--		--	
SVOCs	bis(2-Chloroethoxy)methane	NSV	--		--	
SVOCs	bis(2-Chloroethyl)ether	NSV	--		--	
SVOCs	bis(2-Ethylhexyl)phthalate	30,000	ug/kg	Plant	CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland
SVOCs	Butylbenzylphthalate	30,000	ug/kg	Plant	CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland
SVOCs	Caprolactam	NSV	--		--	
SVOCs	Carbazole	7,000	ug/kg	Invertebrate	Sverdrup 2001; 2002	EC50 of 35,000; UF of 5
SVOCs	Chrysene	HMW PAH	--		--	
SVOCs	Dibenz(a,h)anthracene	HMW PAH	--		--	
SVOCs	Dibenzofuran	4,600	ug/kg	Invertebrate	Sverdrup 2001; 2002	EC50 of 23,000; UF of 5
SVOCs	Diethylphthalate	26,800	ug/kg	Plant	Efroymsen et al. 1997a	EC50 (134,000); UF of 5
SVOCs	Dimethyl phthalate	10,640	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 1,064,000; UF of 100
SVOCs	Di-n-butylphthalate	40,000	ug/kg	Plant	Efroymsen et al. 1997a	LOEC (200,000); UF of 5
SVOCs	Di-n-octylphthalate	30,000	ug/kg	Plant	CCME 2007	Interim Remediation Criteria (IRC) for residential/parkland
SVOCs	Fluoranthene	LMW PAH	--		--	
SVOCs	Fluorene	LMW PAH	--		--	
SVOCs	Hexachlorobenzene	1,000	ug/kg		Beyer 1990	B value ("moderate soil contamination")
SVOCs	Hexachlorobutadiene	NSV	--		--	
SVOCs	Hexachlorocyclopentadiene	2,000	ug/kg	Plant	Efroymsen et al. 1997a	LOEC (10,000); UF of 5
SVOCs	Hexachloroethane	NSV	--		--	
SVOCs	Indeno(1,2,3-cd)pyrene	HMW PAH	--		--	
SVOCs	Isophorone	NSV	--		--	
SVOCs	Naphthalene	LMW PAH	--		--	
SVOCs	Nitrobenzene	2,260	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 226,000; UF of 100
SVOCs	n-Nitroso-di-n-propylamine	NSV	--		--	
SVOCs	n-Nitrosodiphenylamine	1,090	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 109,000; UF of 100
SVOCs	PAH (HMW)	18,000	ug/kg	Eco-SSL - Invertebrate	USEPA 2007f	
SVOCs	PAH (LMW)	29,000	ug/kg	Eco-SSL - Invertebrate	USEPA 2007f	
SVOCs	Pentachlorophenol	5,000	ug/kg	Eco-SSL - Plant	USEPA 2007g	
SVOCs	Phenanthrene	LMW PAH	--		--	
SVOCs	Phenol	1,880	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 188,000; UF of 100
SVOCs	Pyrene	HMW PAH	--		--	

Table J-13

## Ecological Screening Values (ESVs) for Soils - Plants and Soil Invertebrates

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	ESV	Units	Type/Receptor	Reference	Comments
Explosives	1,3,5-Trinitrobenzene	NSV	--		--	
Explosives	1,3-Dinitrobenzene	NSV	--		--	
Explosives	2,4,6-Trinitrotoluene	10,000	ug/kg	Plant	Talmage et al. 1999	
Explosives	2,4-Dinitrotoluene	11,000	ug/kg	Plant/Invertebrate	NRCC 2006	
Explosives	2,6-Dinitrotoluene	8,500	ug/kg	Plant/Invertebrate	NRCC 2006	
Explosives	2-Amino-4,6-dinitrotoluene	80,000	ug/kg	Plant	Talmage et al. 1999	
Explosives	2-Nitrotoluene	NSV	--		--	
Explosives	3,5-Dinitroaniline	NSV	--		--	
Explosives	3-Nitrotoluene	NSV	--		--	
Explosives	4-Amino-2,6-dinitrotoluene	80,000	ug/kg	Plant	2-Amino-4,6-dinitrotoluene	
Explosives	4-Nitrotoluene	NSV	--		--	
Explosives	HMX	10,000	ug/kg	Invertebrate	Talmage et al. 1999	
Explosives	Nitrobenzene	2,260	ug/kg	Invertebrate	Efroymsen et al. 1997b	LC50 of 226,000; UF of 100
Explosives	Nitroglycerine	NSV	--		--	
Explosives	Nitroguanidine	NSV	--		--	
Explosives	PETN	NSV	--		--	
Explosives	RDX	10,000	ug/kg	Invertebrate	Talmage et al. 1999	
Explosives	Tetryl	10,000	ug/kg	Plant	Talmage et al. 1999	

NSV - No Screening Value

Table J-14

## Ecological Screening Values (ESVs) for Surface Water (Applied to Groundwater)

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	Type	Basis <sup>1</sup>	ESV	Units	Hardness (mg/L)	Reference
Filtered Metals	Aluminum	Freshwater	AWQC	87.0	ug/L		USEPA 2009
Filtered Metals	Antimony	Freshwater	FCV	30.0	ug/L		Suter and Tsao 1996
Filtered Metals	Arsenic	Freshwater	AWQC	150	ug/L		USEPA 2009
Filtered Metals	Barium	Freshwater	SCV	4.00	ug/L		Suter and Tsao 1996
Filtered Metals	Beryllium	Freshwater	SCV	0.66	ug/L		Suter and Tsao 1996
Filtered Metals	Cadmium	Freshwater	AWQC	0.25	ug/L	100	USEPA 2009
Filtered Metals	Chromium	Freshwater	AWQC	11.0	ug/L		USEPA 2009
Filtered Metals	Cobalt	Freshwater	SCV	23.0	ug/L		Suter and Tsao 1996
Filtered Metals	Copper	Freshwater	AWQC	8.96	ug/L	100	USEPA 2006a
Filtered Metals	Iron	Freshwater	AWQC	1,000	ug/L		USEPA 2009
Filtered Metals	Lead	Freshwater	AWQC	2.52	ug/L	100	USEPA 2009
Filtered Metals	Manganese	Freshwater	SCV	120	ug/L		Suter and Tsao 1996
Filtered Metals	Mercury	Freshwater	AWQC	0.77	ug/L		USEPA 2009
Filtered Metals	Nickel	Freshwater	AWQC	52.0	ug/L	100	USEPA 2009
Filtered Metals	Selenium	Freshwater	AWQC	4.61	ug/L		USEPA 2009
Filtered Metals	Silver	Freshwater	SCV	0.36	ug/L		Suter and Tsao 1996
Filtered Metals	Thallium	Freshwater	SCV	12.0	ug/L		Suter and Tsao 1996
Filtered Metals	Vanadium	Freshwater	SCV	20.0	ug/L		Suter and Tsao 1996
Filtered Metals	Zinc	Freshwater	AWQC	118	ug/L	100	USEPA 2009
Inorganics	Aluminum	Freshwater	AWQC	87.0	ug/L		USEPA 2009
Inorganics	Antimony	Freshwater	FCV	30.0	ug/L		Suter and Tsao 1996
Inorganics	Arsenic	Freshwater	AWQC	150	ug/L		USEPA 2009
Inorganics	Barium	Freshwater	SCV	4.00	ug/L		Suter and Tsao 1996
Inorganics	Beryllium	Freshwater	SCV	0.66	ug/L		Suter and Tsao 1996
Inorganics	Cadmium	Freshwater	AWQC	0.27	ug/L	100	USEPA 2009
Inorganics	Chromium	Freshwater	AWQC	11.4	ug/L		USEPA 2009
Inorganics	Cobalt	Freshwater	SCV	23.0	ug/L		Suter and Tsao 1996
Inorganics	Copper	Freshwater	AWQC	9.33	ug/L	100	USEPA 2006a
Inorganics	Cyanide	Freshwater	AWQC	5.20	ug/L		USEPA 2009
Inorganics	Iron	Freshwater	AWQC	1,000	ug/L		USEPA 2009

Table J-14

## Ecological Screening Values (ESVs) for Surface Water (Applied to Groundwater)

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Analytical Group	Chemical	Type	Basis <sup>1</sup>	ESV	Units	Hardness (mg/L)	Reference
Inorganics	Lead	Freshwater	AWQC	3.18	ug/L	100	USEPA 2009
Inorganics	Manganese	Freshwater	SCV	120	ug/L		Suter and Tsao 1996
Inorganics	Mercury	Freshwater	AWQC	0.91	ug/L		USEPA 2009
Inorganics	Nickel	Freshwater	AWQC	52.2	ug/L	100	USEPA 2009
Inorganics	Selenium	Freshwater	AWQC	5.00	ug/L		USEPA 2009
Inorganics	Silver	Freshwater	SCV	0.36	ug/L		Suter and Tsao 1996
Inorganics	Thallium	Freshwater	SCV	12.0	ug/L		Suter and Tsao 1996
Inorganics	Vanadium	Freshwater	SCV	20.0	ug/L		Suter and Tsao 1996
Inorganics	Zinc	Freshwater	AWQC	120	ug/L	100	USEPA 2009
Filtered Metals	Aluminum	Marine		NSV	--		--
Filtered Metals	Antimony	Marine		500	ug/L		USEPA 2006b
Filtered Metals	Arsenic	Marine	AWQC	36.0	ug/L		USEPA 2009
Filtered Metals	Barium	Marine		200	ug/L		Buchman 2008
Filtered Metals	Beryllium	Marine		100	ug/L		Buchman 2008
Filtered Metals	Cadmium	Marine	AWQC	8.80	ug/L		USEPA 2009
Filtered Metals	Chromium	Marine	AWQC	50.0	ug/L		USEPA 2009
Filtered Metals	Cobalt	Marine		NSV	--		--
Filtered Metals	Copper	Marine	AWQC	3.10	ug/L		USEPA 2009
Filtered Metals	Iron	Marine		NSV	--		--
Filtered Metals	Lead	Marine	AWQC	8.10	ug/L		USEPA 2009
Filtered Metals	Manganese	Marine		100	ug/L		Buchman 2008
Filtered Metals	Mercury	Marine	AWQC	0.94	ug/L		USEPA 2009
Filtered Metals	Nickel	Marine	AWQC	8.20	ug/L		USEPA 2009
Filtered Metals	Selenium	Marine	AWQC	71.0	ug/L		USEPA 2009
Filtered Metals	Silver	Marine		0.23	ug/L		USEPA 2001
Filtered Metals	Thallium	Marine		21.3	ug/L		USEPA 2001
Filtered Metals	Vanadium	Marine		50.0	ug/L		Buchman 2008
Filtered Metals	Zinc	Marine	AWQC	81.0	ug/L		USEPA 2009
Inorganics	Aluminum	Marine		NSV	--		--
Inorganics	Antimony	Marine		500	ug/L		USEPA 2006b

**Table J-14**

**Ecological Screening Values (ESVs) for Surface Water (Applied to Groundwater)**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Analytical Group	Chemical	Type	Basis <sup>1</sup>	ESV	Units	Hardness (mg/L)	Reference
Inorganics	Arsenic	Marine	AWQC	36.0	ug/L		USEPA 2009
Inorganics	Barium	Marine		200	ug/L		Buchman 2008
Inorganics	Beryllium	Marine		100	ug/L		Buchman 2008
Inorganics	Cadmium	Marine	AWQC	8.85	ug/L		USEPA 2009
Inorganics	Chromium	Marine	AWQC	50.4	ug/L		USEPA 2009
Inorganics	Cobalt	Marine		NSV	--		--
Inorganics	Copper	Marine	AWQC	3.73	ug/L		USEPA 2009
Inorganics	Cyanide	Marine	AWQC	1.00	ug/L		USEPA 2009
Inorganics	Iron	Marine		NSV	--		--
Inorganics	Lead	Marine	AWQC	8.52	ug/L		USEPA 2009
Inorganics	Manganese	Marine		100	ug/L		Buchman 2008
Inorganics	Mercury	Marine	AWQC	1.11	ug/L		USEPA 2009
Inorganics	Nickel	Marine	AWQC	8.28	ug/L		USEPA 2009
Inorganics	Selenium	Marine	AWQC	71.1	ug/L		USEPA 2009
Inorganics	Silver	Marine		0.23	ug/L		USEPA 2001
Inorganics	Thallium	Marine		21.3	ug/L		USEPA 2001
Inorganics	Vanadium	Marine		50.0	ug/L		Buchman 2008
Inorganics	Zinc	Marine	AWQC	85.6	ug/L		USEPA 2009

1 - AWQC: Ambient Water Quality Criterion; FCV: Final Chronic Value; SCV: Secondary Chronic Value;

**Table J-15**

**Uncertainty Factors**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

<b>Convert From</b>	<b>Convert To</b>	<b>Uncertainty Factor</b>
Chronic NOAEL or NOEC	Chronic NOAEL or NOEC	1
Chronic LOAEL or LOEC	Chronic NOAEL or NOEC	5
Chronic NOAEL or NOEC	Chronic LOAEL or LOEC	5
Subchronic NOAEL or NOEC	Chronic NOAEL or NOEC	10
Subchronic LOAEL or LOEC	Chronic NOAEL or NOEC	20
Acute NOAEL or NOEC	Chronic NOAEL or NOEC	30
Acute LOAEL or LOEC	Chronic NOAEL or NOEC	50
LD50 or LC50	Chronic NOAEL or NOEC	100

Uncertainty factors from Wentsel et al. (1996)

Durations are defined as follows (USEPA 1999; Sample et al. 1996):

- Acute: <3 days (plants, invertebrates) and <14 days (fish, birds, mammals)
- Subchronic: 3 - 6 days (plants, invertebrates) and 14 - 90 days (fish, birds, mammals)
- Chronic: >7 days (plants, invertebrates) and >90 days or during critical life stage (fish, birds, mammals)

**Table J-16****Eco-SSL Values for Birds and Mammals****Remedial Investigation Report***Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

<b>Chemical</b>	<b>Bird</b>	<b>Mammal</b>	<b>Units</b>	<b>Reference</b>
<b>Metals</b>				
Arsenic	43.0	46.0	mg/kg	USEPA 2005b
Cadmium	0.77	0.36	mg/kg	USEPA 2005e
Chromium	26.0	34.0	mg/kg	USEPA 2008a
Copper	28.0	49.0	mg/kg	USEPA 2007a
Lead	11.0	56.0	mg/kg	USEPA 2005g
Nickel	210	130	mg/kg	USEPA 2007c
Selenium	1.20	0.63	mg/kg	USEPA 2007d
Silver	4.20	14.0	mg/kg	USEPA 2006c
Zinc	46.0	79.0	mg/kg	USEPA 2007e
<b>Organics</b>				
Pentachlorophenol	2.10	2.80	mg/kg	USEPA 2007g
PAHs - LMW	--	100	mg/kg	USEPA 2007f
PAHs - HMW	--	1.10	mg/kg	USEPA 2007f

Table J-17  
Ingestion-Based Toxicity Reference Values (TRVs) for Mammals  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Chemical Form	Test Organism	Duration	Critical Life Stage?	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	Reference	NOAEL (mg/kg/d)	Reference	MATC (mg/kg/d)	Meadow vole	Red fox	Short-tailed shrew	White-footed mouse
<b>Metals</b>															
Arsenic	Arsenite (As+3)	mouse	3 generations	Yes	oral in water/food	reproduction	1.26	Sample et al. 1996	0.252 <sup>a</sup>	--	0.56	X		X	X
Arsenic	--	dog	chronic	--	oral	survival, growth, reproduction	1.66	USEPA 2005b	1.04	USEPA 2005b	1.31		X		
Cadmium	--	rat	chronic	--	oral	survival, growth, reproduction	7.70	USEPA 2005e	0.77	USEPA 2005e	2.43	X	X	X	X
Chromium	Cr+3	multiple	chronic	--	oral	survival, growth, reproduction	12.0 <sup>b</sup>	--	2.40	USEPA 2008a	5.37	X	X	X	X
Copper	--	pig	chronic	--	oral	survival, growth, reproduction	9.34	USEPA 2007a	5.60	USEPA 2007a	7.23	X		X	X
Copper	Copper sulfate	mink	357 days	Yes	oral in diet	reproduction	15.1	Sample et al. 1996	11.7	Sample et al. 1996	13.3		X		
Lead	--	rat	chronic	--	oral	survival, growth, reproduction	8.90	USEPA 2005g	4.70	USEPA 2005g	6.47	X	X	X	X
Mercury	Methyl mercury chloride	rat	3 generations	Yes	oral in diet	reproduction	0.160	Sample et al. 1996	0.032	Sample et al. 1996	0.072	X		X	X
Mercury	Methyl mercury chloride	mink	93 days	No	oral in diet	survival/weight loss/ataxia	0.247 <sup>c</sup>	Sample et al. 1996	0.150 <sup>c</sup>	Sample et al. 1996	0.192		X		
Nickel	--	multiple	chronic	--	oral	survival, growth, reproduction	3.40	USEPA 2007c	1.70	USEPA 2007c	2.40	X	X	X	X
Selenium	Potassium selenate (SeO4)	rat	1 year	Yes	oral in water	reproduction	0.33	Sample et al. 1996	0.20	Sample et al. 1996	0.26	X	X	X	X
Silver	--	pig	chronic	--	oral	survival, growth, reproduction	60.2	USEPA 2006c	12.0 <sup>a</sup>	--	26.9	X	X	X	X
Zinc	--	multiple	chronic	--	oral	survival, growth, reproduction	377 <sup>b</sup>	--	75.4	USEPA 2007e	169	X	X	X	X
<b>Semivolatile Organic Compounds</b>															
4-Bromophenyl-phenylether	--	--	--		--	--	NA	--	NA	--	NA	X	X	X	X
4-Chlorophenyl-phenylether	--	--	--		--	--	NA	--	NA	--	NA	X	X	X	X
Acenaphthene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Acenaphthylene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Anthracene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Benzo(a)anthracene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Benzo(a)pyrene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Benzo(b)fluoranthene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Benzo(g,h,i)perylene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Benzo(k)fluoranthene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Chrysene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Dibenz(a,h)anthracene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Fluoranthene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Fluorene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Hexachlorobenzene	--	rat	4 generations	Yes	oral in diet	reproduction	4.00	ATSDR 2002	2.00	ATSDR 2002	2.83	X	X	X	X
Hexachlorobutadiene	--	rat	GD 1-22; LD 1-21	Yes	oral in diet	developmental	20.0	ATSDR 1994	2.00	ATSDR 1994	6.32	X	X	X	X
Hexachlorocyclopentadiene	--	mouse	GD 6-15	Yes	oral (gavage)	developmental	375 <sup>b</sup>	--	75.0	ATSDR 1999	168	X	X	X	X
Hexachloroethane	--	rat	GD 6-16	Yes	oral (gavage)	reproduction	500	ATSDR 1997	100	ATSDR 1997	224	X	X	X	X
Indeno(1,2,3-cd)pyrene	--	mouse	65 weeks	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X
Pentachlorophenol	--	multiple	chronic	--	oral	survival, growth, reproduction	42.1 <sup>b</sup>	--	8.42	USEPA 2007g	18.8	X	X	X	X
Phenanthrene	--	rat	chronic	--	oral	survival, growth, reproduction	328	USEPA 2007f	65.6	USEPA 2007f	147	X	X	X	X
Pyrene	--	mouse	chronic	--	oral	survival, growth, reproduction	3.07	USEPA 2007f	0.615	USEPA 2007f	1.37	X	X	X	X

NA - Not Available

<sup>a</sup> Uncertainty factor of 5 applied to LOAEL

<sup>b</sup> Uncertainty factor of 5 applied to NOAEL

<sup>c</sup> Does not include subchronic uncertainty factor of 10 applied by Sample et al (1996) since the study duration meets the criteria for a chronic study in Table J-15

Table J-18  
Ingestion-Based Toxicity Reference Values (TRVs) for Birds  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Chemical Form	Test Organism	Duration	Critical Life Stage?	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	Reference	NOAEL (mg/kg/d)	Reference	MATC (mg/kg/d)	American robin	Mourning dove	Red-tailed hawk
<b>Metals</b>														
Arsenic	Copper acetoarsenite	brown-headed cowbird	7 months	No	oral in diet	survival	7.38	Sample et al. 1996	2.46	Sample et al. 1996	4.26	X		X
Arsenic	--	chicken	chronic	--	oral	survival, growth,reproduction	11.2 b	--	2.24	USEPA 2005b	5.01		X	
Cadmium	--	multiple	chronic	--	oral	survival, growth,reproduction	7.35 b	--	1.47	USEPA 2005e	3.29	X	X	X
Chromium	Cr+3	multiple	chronic	--	oral	survival, growth,reproduction	13.3 b	--	2.66	USEPA 2008a	5.95	X	X	X
Copper	--	chicken	chronic	--	oral	survival, growth,reproduction	12.1	USEPA 2007a	4.05	USEPA 2007a	7.00	X	X	X
Lead	--	chicken	chronic	--	oral	survival, growth,reproduction	3.26	USEPA 2005g	1.63	USEPA 2005g	2.31		X	
Lead	Metallic	American kestrel	7 months	Yes	oral in diet	reproduction	19.3 b	--	3.85	Sample et al. 1996	8.61	X		X
Mercury	Mercury chloride	Japanese quail	1 year	Yes	oral in diet	reproduction	0.90	Sample et al. 1996	0.45	Sample et al. 1996	0.64		X	
Mercury	--	red-tailed hawk	12 weeks	Yes	oral in diet	survival/neurological	1.20	USEPA 1995b	0.49	USEPA 1995b	0.77	X		X
Nickel	--	multiple	chronic	--	oral	survival, growth,reproduction	33.6 b	--	6.71	USEPA 2007c	15.0	X	X	X
Selenium	Selanomethionine	screech owl	13.7 weeks	Yes	oral in diet	reproduction	1.50	Sample et al. 1996	0.44	Sample et al. 1996	0.81	X		X
Selenium	--	chicken	chronic	--	oral	survival, growth,reproduction	0.58	USEPA 2007d	0.29	USEPA 2007d	0.41		X	
Silver	--	turkey	chronic	--	oral	survival, growth	20.2	USEPA 2006c	4.04 a	--	9.03	X	X	X
Zinc	--	multiple	chronic	--	oral	survival, growth,reproduction	331 b	--	66.1	USEPA 2007e	148	X	X	X
<b>Semivolatile Organic Compounds</b>														
4-Bromophenyl-phenylether	--	--	--	--	--	--	NA	--	NA	--	NA	X	X	X
4-Chlorophenyl-phenylether	--	--	--	--	--	--	NA	--	NA	--	NA	X	X	X
Acenaphthene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Acenaphthylene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Anthracene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Benzo(a)anthracene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Benzo(a)pyrene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Rigdon and Neal 1963	15.9	X	X	X
Benzo(b)fluoranthene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Benzo(g,h,i)perylene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Benzo(k)fluoranthene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Chrysene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Dibenz(a,h)anthracene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Fluoranthene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Fluorene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Hexachlorobenzene	--	Japanese quail	90 days	Yes	oral in diet	reproduction	0.565	Coulston and Kolbye 1994; TERRETOX 2002	0.113	Coulston and Kolbye 1994; TERRETOX 2002	0.253	X	X	X
Hexachlorobutadiene	--	Japanese quail	90 days	Yes	oral in diet	reproduction	17.0 b	--	3.39	Coulston and Kolbye 1994; TERRETOX 2002	7.58	X	X	X
Hexachlorocyclopentadiene	--	--	--	--	--	--	NA	--	NA	--	NA	X	X	X
Hexachloroethane	--	--	--	--	--	--	NA	--	NA	--	NA	X	X	X
Indeno(1,2,3-cd)pyrene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Pentachlorophenol	--	chicken	chronic	--	oral	survival, growth,reproduction	67.3	USEPA 2007g	6.73	USEPA 2007g	21.3	X	X	X
Phenanthrene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X
Pyrene	--	chicken	35 days	No	oral in diet	reproduction	35.5 b	--	7.10 c	Benzo(a)pyrene value	15.9	X	X	X

NA - Not Available

<sup>a</sup> Uncertainty factor of 5 applied to LOAEL

<sup>b</sup> Uncertainty factor of 5 applied to NOAEL

<sup>c</sup> Subchronic to chronic uncertainty factor of 10 applied

Table J-19  
Ecological Screening Statistics - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Semivolatile Organic Compounds (UG/KG)																		
1,1-Biphenyl	370 - 460	0 / 7	--	--	--	201	16.7	--	13,600	-- / --	0.03	NO	--	-- / --	--	--	--	NO
2,2'-Oxybis(1-chloropropane)	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
2,4,5-Trichlorophenol	940 - 1,200	0 / 7	--	--	--	506	50.1	--	1,350	-- / --	0.89	NO	--	-- / --	--	--	--	NO
2,4,6-Trichlorophenol	370 - 460	0 / 7	--	--	--	201	16.7	--	580	-- / --	0.79	NO	--	-- / --	--	--	--	NO
2,4-Dichlorophenol	370 - 460	0 / 7	--	--	--	201	16.7	--	500	-- / --	0.92	NO	--	-- / --	--	--	--	NO
2,4-Dimethylphenol	370 - 460	0 / 7	--	--	--	201	16.7	--	1,000	-- / --	0.46	NO	--	-- / --	--	--	--	NO
2,4-Dinitrophenol	940 - 1,200	0 / 7	--	--	--	506	50.1	--	20,000	-- / --	0.06	NO	--	-- / --	--	--	--	NO
2-Chloronaphthalene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
2-Chlorophenol	370 - 460	0 / 7	--	--	--	201	16.7	--	500	-- / --	0.92	NO	--	-- / --	--	--	--	NO
2-Methylnaphthalene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
2-Methylphenol	370 - 460	0 / 7	--	--	--	201	16.7	--	1,000	-- / --	0.46	NO	--	-- / --	--	--	--	NO
2-Nitroaniline	940 - 1,200	0 / 7	--	--	--	506	50.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
2-Nitrophenol	370 - 460	0 / 7	--	--	--	201	16.7	--	1,000	-- / --	0.46	NO	--	-- / --	--	--	--	NO
3,3'-Dichlorobenzidine	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
3-Nitroaniline	940 - 1,200	0 / 7	--	--	--	506	50.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4,6-Dinitro-2-methylphenol	940 - 1,200	0 / 7	--	--	--	506	50.1	--	1,000	-- / --	1.20	YES	--	-- / --	--	--	0.51	NO
4-Bromophenyl-phenylether	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Chloro-3-methylphenol	370 - 460	0 / 7	--	--	--	201	16.7	--	500	-- / --	0.92	NO	--	-- / --	--	--	--	NO
4-Chloroaniline	370 - 460	0 / 7	--	--	--	201	16.7	--	500	-- / --	0.92	NO	--	-- / --	--	--	--	NO
4-Chlorophenyl-phenylether	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Methylphenol	370 - 460	0 / 7	--	--	--	201	16.7	--	1,000	-- / --	0.46	NO	--	-- / --	--	--	--	NO
4-Nitroaniline	940 - 1,200	0 / 7	--	--	--	506	50.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Nitrophenol	940 - 1,000	0 / 4	--	--	--	481	13.1	--	380	-- / --	2.63	YES	--	-- / --	--	--	1.27	NO <sup>4</sup>
Acenaphthene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Acenaphthylene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Acetophenone	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Anthracene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Atrazine	370 - 460	0 / 7	--	--	--	201	16.7	--	11.9	-- / --	38.7	YES	--	-- / --	--	--	16.9	NO <sup>4</sup>
Benzaldehyde	370 - 460	1 / 7	320	320	CAA06-SS01-1008	217	48.3	--	58,400	0 / 7	0.01	NO	--	-- / --	--	--	--	NO
Benzo(a)anthracene	370 - 460	1 / 7	110	110	CAA06-SS01-1008	187	37.8	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(a)pyrene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(b)fluoranthene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(g,h,i)perylene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(k)fluoranthene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
bis(2-Chloroethoxy)methane	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
bis(2-Chloroethyl)ether	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
bis(2-Ethylhexyl)phthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Butylbenzylphthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Caprolactam	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Carbazole	370 - 460	0 / 7	--	--	--	201	16.7	--	7,000	-- / --	0.07	NO	--	-- / --	--	--	--	NO
Chrysene	370 - 460	1 / 7	150	150	CAA06-SS01-1008	193	25.1	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO

Table J-19  
Ecological Screening Statistics - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Dibenz(a,h)anthracene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Dibenzofuran	370 - 460	0 / 7	--	--	--	201	16.7	--	4,600	-- / --	0.10	NO	--	-- / --	--	--	--	NO
Diethylphthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	26,800	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Dimethyl phthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	10,640	-- / --	0.04	NO	--	-- / --	--	--	--	NO
Di-n-butylphthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	40,000	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Di-n-octylphthalate	370 - 460	0 / 7	--	--	--	201	16.7	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Fluoranthene	370 - 460	1 / 7	300	300	CAA06-SS01-1008	214	41.3	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Fluorene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Hexachlorobenzene	370 - 460	0 / 7	--	--	--	201	16.7	--	1,000	-- / --	0.46	NO	--	-- / --	--	--	--	NO
Hexachlorobutadiene	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Hexachlorocyclopentadiene	370 - 460	0 / 7	--	--	--	201	16.7	--	2,000	-- / --	0.23	NO	--	-- / --	--	--	--	NO
Hexachloroethane	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Indeno(1,2,3-cd)pyrene	370 - 460	0 / 7	--	--	--	201	16.7	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Isophorone	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Naphthalene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
n-Nitroso-di-n-propylamine	370 - 460	0 / 7	--	--	--	201	16.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
n-Nitrosodiphenylamine	370 - 460	0 / 7	--	--	--	201	16.7	--	1,090	-- / --	0.42	NO	--	-- / --	--	--	--	NO
PAH (HMW)	1,665 - 2,070	1 / 7	2,070	2,070	CAA06-SS01-1008	1,067	448	--	18,000	0 / 7	0.12	NO	--	-- / --	--	--	--	NO
PAH (LMW)	1,665 - 2,070	1 / 7	1,940	1,940	CAA06-SS01-1008	1,049	400	--	29,000	0 / 7	0.07	NO	--	-- / --	--	--	--	NO
Pentachlorophenol	940 - 1,200	0 / 7	--	--	--	506	50.1	--	5,000	-- / --	0.24	NO	--	-- / --	--	--	--	NO
Phenanthrene	370 - 460	0 / 7	--	--	--	201	16.7	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Phenol	370 - 460	0 / 7	--	--	--	201	16.7	--	1,880	-- / --	0.24	NO	--	-- / --	--	--	--	NO
Pyrene	370 - 460	1 / 7	580	580	CAA06-SS01-1008	254	145	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
<b>Explosives (UG/KG)</b>																		
1,3,5-Trinitrobenzene	99.0 - 390	5 / 20	250	20,000	CAA06-SO26-000H-0913	1,195	4,433	5,903	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
1,3-Dinitrobenzene	99.0 - 390	4 / 20	84.0	2,500	CAA06-SO26-000H-0913	262	547	488	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
2,4,6-Trinitrotoluene	99.0 - 390	10 / 20	170	14,000,000	CAA06-SO26-000H-0913	1,025,577	3,217,268	2,303,610	10,000	6 / 20	1,400	<b>YES</b>	--	-- / --	--	230	103	<b>YES</b>
2,4-Dinitrotoluene	99.0 - 460	5 / 20	140	6,300	CAA06-SS01-1008	527	1,389	--	11,000	0 / 20	0.57	NO	--	-- / --	--	--	--	NO
2,6-Dinitrotoluene	99.0 - 460	1 / 20	310	310	CAA06-SO26-000H-0913	149	60.3	--	8,500	0 / 20	0.04	NO	--	-- / --	--	--	--	NO
2-Amino-4,6-dinitrotoluene	99.0 - 390	6 / 20	870	16,000	CAA06-SS02-1008	2,150	4,830	--	80,000	0 / 20	0.20	NO	--	-- / --	--	--	--	NO
2-Nitrotoluene	200 - 390	1 / 19	48,000	48,000	CAA06-SS02-1008	2,635	10,986	--	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
3,5-Dinitroaniline	99.0 - 390	2 / 20	890	1,600	CAA06-SO26-000H-0913	211	374	--	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
3-Nitrotoluene	200 - 390	0 / 19	--	--	--	114	22.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Amino-2,6-dinitrotoluene	99.0 - 390	7 / 19	710	17,000	CAA06-SS02-1008	2,783	5,430	--	80,000	0 / 19	0.21	NO	--	-- / --	--	--	--	NO
4-Nitrotoluene	200 - 390	0 / 19	--	--	--	114	22.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
HMX	200 - 390	0 / 20	--	--	--	114	21.7	--	10,000	-- / --	0.04	NO	--	-- / --	--	--	--	NO
Nitrobenzene	99.0 - 460	0 / 20	--	--	--	140	46.9	--	2,260	-- / --	0.20	NO	--	-- / --	--	--	--	NO
Nitroglycerin	220 - 5,000	0 / 20	--	--	--	704	897	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Nitroguanidine	10.0 - 130	0 / 7	--	--	--	37.9	30.8	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
PETN	220 - 500	0 / 20	--	--	--	166	66.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
RDX	200 - 390	2 / 20	220	380	CAA06-SO26-000H-0913	132	66.5	--	10,000	0 / 20	0.04	NO	--	-- / --	--	--	--	NO
Tetryl	200 - 390	1 / 20	640	640	CAA06-SS01-1008	141	120	--	10,000	0 / 20	0.06	NO	--	-- / --	--	--	--	NO

Table J-19  
Ecological Screening Statistics - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Inorganics (MG/KG)																		
Aluminum	-- - --	20 / 20	2,700	25,000	CAA06-SS03-1008	7,857	4,891	9,748	pH < 5.5	16 / 20	--	YES	12,200	1 / 20	2.05	--	--	NO
Antimony	0.097 - 14.0	11 / 20	0.089	0.62	CAA06-SS38-0913	0.99	1.73	--	78.0	0 / 20	0.01	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	20 / 20	1.10	11.8	CAA06-SS03-1008	3.87	2.70	--	18.0	0 / 20	0.66	NO	--	-- / --	--	--	--	NO
Barium	-- - --	20 / 20	9.40	45.7	CAA06-SS03-1008	21.5	8.22	--	330	0 / 20	0.14	NO	--	-- / --	--	--	--	NO
Beryllium	-- - --	20 / 20	0.092	0.58	CAA06-SS28-0913	0.33	0.12	--	40.0	0 / 20	0.01	NO	--	-- / --	--	--	--	NO
Cadmium	0.020 - 0.38	17 / 20	0.017	0.29	CAA06-SO26-000H-0913	0.060	0.069	--	32.0	0 / 20	0.01	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	20 / 20	61.0	4,000	CAA06-SO26-000H-0913	736	977	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium (hexavalent)	0.23 - 0.30	0 / 2	--	--	--	0.13	0.025	--	0.40	-- / --	0.75	NO	--	-- / --	--	--	--	NO
Chromium	-- - --	22 / 22	3.60	34.7	CAA06-SS03-1008	11.0	7.12	13.6	64.0	0 / 22	0.54	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	20 / 20	0.57	3.60	CAA06-SS01-1008	2.05	0.80	--	13.0	0 / 20	0.28	NO	--	-- / --	--	--	--	NO
Copper	2.20 - 4.80	17 / 20	1.20	13.0	CAA06-SS36-0913	3.94	3.38	--	70.0	0 / 20	0.19	NO	--	-- / --	--	--	--	NO
Cyanide	0.042 - 0.70	10 / 20	0.047	1.30	CAA06-SS13-1108	0.24	0.29	--	15.8	0 / 20	0.08	NO	--	-- / --	--	--	--	NO
Iron	-- - --	20 / 20	3,800	38,000	CAA06-SO26-000H-0913	11,398	10,046	15,800	5 < pH > 8	12 / 20	--	YES	19,900	3 / 20	1.91	Mean pH in range		NO
Lead	-- - --	20 / 20	9.90	1,100	CAA06-SO26-000H-0913	123	263	379	120	3 / 20	9.17	YES	17.4	14 / 20	63.2	3.16	1.02	YES
Magnesium <sup>3</sup>	-- - --	20 / 20	200	1,270	CAA06-SS03-1008	560	253	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	20 / 20	12.0	175	CAA06-SS01-1008	43.6	35.7	--	220	0 / 20	0.80	NO	--	-- / --	--	--	--	NO
Mercury	0.038 - 0.15	15 / 20	0.046	0.13	CAA06-SS01-1008	0.066	0.028	0.08	0.10	2 / 20	1.30	YES	0.111	2 / 20	1.17	0.79	0.66	NO
Nickel	-- - --	20 / 20	1.60	10.1	CAA06-SS01-1008	4.63	2.31	--	38.0	0 / 20	0.27	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	20 / 20	180	1,520	CAA06-SS03-1008	487	324	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.14 - 4.30	14 / 20	0.049	2.00	CAA06-SS01-1008	0.56	0.70	0.55	0.52	2 / 20	3.85	YES	0.51	2 / 20	3.92	1.05	1.08	YES
Silver	0.67 - 2.30	13 / 20	0.017	0.055	CAA06-SS38-0913	0.21	0.30	--	560	0 / 20	0.0001	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	7.20 - 36.3	11 / 20	8.70	68.0	CAA06-SS01-1008	18.5	17.9	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.090 - 5.70	14 / 20	0.058	0.18	CAA06-SS03-1008	0.45	0.73	--	1.00	0 / 20	0.18	NO	--	-- / --	--	--	--	NO
Vanadium	-- - --	20 / 20	7.60	50.0	CAA06-SS03-1008	18.9	9.64	--	130	0 / 20	0.38	NO	--	-- / --	--	--	--	NO
Zinc	15.0 - 19.0	17 / 20	7.10	176	CAA06-SS03-1008	34.4	44.9	78.7	120	2 / 20	1.47	YES	26.5	5 / 20	6.64	0.66	0.29	NO
Other Parameters																		
pH	-- - --	20 / 20	4.10	7.10	CAA06-SS03-1008	5.20	0.87	--	--	-- / --	--	--	--	-- / --	--	--	--	--
Total organic carbon (MG/KG)	-- - --	20 / 20	6,200	120,000	CAA06-SS01-1008	30,875	33,656	--	--	-- / --	--	--	--	-- / --	--	--	--	--

NSV - No Screening Value  
1 - Count of detected samples exceeding or equaling Screening Value  
2 - Shaded cells indicate hazard quotient based on reporting limits  
3 - Macronutrient - Not considered to be a COPC  
4 - See uncertainty section

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13	CAA06-SO26		
			CAA06-SS01-1008	CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108	CAA06-SS13-1108	CAA06-SO26-000H-0913	CAA06-SS26-0913	CAA06-SS26P-0913
			10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08	09/19/13	09/19/13	09/19/13
Semivolatile Organic Compounds (UG/KG)												
Benzaldehyde	58,400	--	320 J	380 U	380 U	380 U	460 U	430 U	370 U	NA	NA	NA
Benzo(a)anthracene	HMW PAH	--	110 J	380 U	380 U	380 U	460 U	430 U	370 U	NA	NA	NA
Chrysene	HMW PAH	--	150 J	380 U	380 U	380 U	460 U	430 U	370 U	NA	NA	NA
Fluoranthene	LMW PAH	--	300 J	380 U	380 U	380 U	460 U	430 U	370 U	NA	NA	NA
PAH (HMW)	18,000	--	2,070 J	1,710 U	1,710 U	1,710 U	2,070 U	1,935 U	1,665 U	NA	NA	NA
PAH (LMW)	29,000	--	1,940 J	1,710 U	1,710 U	1,710 U	2,070 U	1,935 U	1,665 U	NA	NA	NA
Pyrene	HMW PAH	--	580 J	380 U	380 U	380 U	460 U	430 U	370 U	NA	NA	NA
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	NSV	--	620 K	250	100 U	100 U	100 U	99 U	1,100	20,000	NA	NA
1,3-Dinitrobenzene	NSV	--	730 J	84 J	100 UJ	100 U	100 U	99 U	290	2,500	NA	NA
2,4,6-Trinitrotoluene	10,000	--	4,500,000	320,000	6,600	170	100 U	99 U	51,000	14,000,000	NA	NA
2,4-Dinitrotoluene	11,000	--	6,300 L	140 J	380 U	380 U	460 U	99 U	290	270 U	NA	NA
2,6-Dinitrotoluene	8,500	--	410 U	380 U	380 U	380 U	460 U	99 U	370 U	310 J	NA	NA
2-Amino-4,6-dinitrotoluene	80,000	--	100 UJ	16,000 J	1,400 J	100 U	100 U	99 U	15,000	270 U	NA	NA
2-Nitrotoluene	NSV	--	40,000 R	48,000 J	200 UJ	200 U	200 U	200 U	200 U	270 U	NA	NA
3,5-Dinitroaniline	NSV	--	100 U	100 U	100 U	100 U	100 U	99 UJ	890	1,600	NA	NA
4-Amino-2,6-dinitrotoluene	80,000	--	20,000 R	17,000	1,400	100 U	100 U	99 U	14,000	270 U	NA	NA
RDX	10,000	--	220	200 U	200 U	200 U	200 U	200 U	200 U	380 J	NA	NA
Tetryl	10,000	--	640	200 U	200 U	200 U	200 U	200 U	200 U	270 U	NA	NA
Inorganics (MG/KG)												
Aluminum	pH < 5.5	12,200	10,600	10,400	25,000	9,630	5,230	6,780	11,400	7,600	NA	NA
Antimony	78.0	11.0	14 UL	4.1 UL	0.21 L	0.1 L	4.5 UL	7.4 UL	4 UL	0.31	NA	NA
Arsenic	18.0	6.36	8.1 J	3.5 J	11.8 J	3.6 J	2.7 L	3.3 L	5 L	6.1	NA	NA
Barium	330	52.9	31	22.9	45.7	18.8 J	21.2 K	18.3 K	25.2 K	32	NA	NA
Beryllium	40.0	0.587	0.34 J	0.36	0.55	0.29 J	0.4	0.26 J	0.39	0.35	NA	NA
Cadmium	32.0	1.50	0.06 J	0.09 J	0.12 J	0.04 J	0.38 U	0.05 B	0.02 B	0.29	NA	NA
Chromium	64.0	18.2	16.8 L	12.5 L	34.7 L	16.2 L	6.1	8.6	13.9	10	20	17
Cobalt	13.0	9.93	3.6 J	2.2 J	3.4 J	1.9 J	2.6 J	1.3 J	2.4 J	2.2	NA	NA
Copper	70.0	4.25	9.8	6.7	5.5	3.6	2.2 B	4.8 B	4.2 B	9.5	NA	NA
Cyanide	15.8	--	0.6 U	0.55 U	0.55 U	0.5 U	0.7 U	0.6 U	1.3	0.57	NA	NA
Iron	5 < pH > 8	19,900	37,100 J	9,000 J	21,700 J	9,010 J	4,780	6,270	10,300	38,000	NA	NA
Lead	120	17.4	580 J	72.9 J	42.8 J	9.9 J	10.8	18.5	101	1,100	NA	NA
Manganese	220	324	175	43.3	32.8	25.4	50.5 L	30.9 L	41.1 L	92	NA	NA
Mercury	0.10	0.111	0.13 L	0.05 L	0.12 UL	0.11 UL	0.15 UL	0.06 L	0.08 L	0.13	NA	NA
Nickel	38.0	9.52	10.1	6.6	10	4.8	3.7	4.1 J	7	6.3	NA	NA
Selenium	0.52	0.51	2 J	0.38 J	0.91 J	3.8 U	2.6 U	4.3 U	0.38 J	0.33	NA	NA
Silver	560	2.10	2.3 U	0.69 U	0.95 U	1.1 U	0.75 U	1.2 U	0.67 U	0.052	NA	NA
Thallium	1.00	--	5.7 U	1.7 U	0.18 J	2.7 U	1.9 U	3.1 U	0.09 B	0.095	NA	NA
Vanadium	130	27.9	26.6	19.6	50	22.1	10.3	18.1	22.5	25	NA	NA
Zinc	120	26.5	96.7	54.9	176	17	12.2 K	18.6 K	25.9 K	120	NA	NA
Other Parameters												
pH	--	--	4.60	6.80	7.10	7.10	5.40	5.00	5.00	5.70	NA	NA

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13	CAA06-SO26		
			CAA06-SS01-1008	CAA06-SS02-1008	CAA06-SS03-1008	CAA06-SS04-1008	CAA06-SS07-1108	CAA06-SS08-1108	CAA06-SS13-1108	CAA06-SO26-000H-0913	CAA06-SS26-0913	CAA06-SS26P-0913
			10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08	09/19/13	09/19/13	09/19/13
Total organic carbon (MG/KG)	--	--	120,000 J	7,300 J	6,200 J	27,000 J	22,000	49,000	30,000	120,000	NA	NA

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

**Bold indicates detections**

NSV - No Screening Value

NA - Not analyzed

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-MW01	CAA06-MW02	
			CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913	CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913
			09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13	09/17/13	09/17/13
Semivolatile Organic Compounds (UG/KG)												
Benzaldehyde	58,400	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	HMW PAH	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	HMW PAH	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	LMW PAH	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PAH (HMW)	18,000	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PAH (LMW)	29,000	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	HMW PAH	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
1,3-Dinitrobenzene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
2,4,6-Trinitrotoluene	10,000	--	NA	230 U	220 U	770	1,900	220 U	220 U	220 U	270 U	270 U
2,4-Dinitrotoluene	11,000	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
2,6-Dinitrotoluene	8,500	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
2-Amino-4,6-dinitrotoluene	80,000	--	NA	230 U	220 U	870	1,200	220 U	220 U	220 U	270 U	270 U
2-Nitrotoluene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
3,5-Dinitroaniline	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
4-Amino-2,6-dinitrotoluene	80,000	--	NA	230 U	220 U	710	980	220 U	220 U	220 U	270 U	270 U
RDX	10,000	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
Tetryl	10,000	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	220 U	270 U	270 U
Inorganics (MG/KG)												
Aluminum	pH < 5.5	12,200	NA	12,000	7,600	6,800	4,400	4,200	4,900	3,600	7,600	8,500
Antimony	78.0	11.0	NA	0.2	0.23	0.16	0.1	0.089 J	0.12	0.097 B	0.2 B	0.2 B
Arsenic	18.0	6.36	NA	6	5.4	2.7	1.2	1.1	1.6	1.7	5.2	5.2
Barium	330	52.9	NA	27	13	15	15	16	20	22	18	20
Beryllium	40.0	0.587	NA	0.58	0.4	0.19	0.19	0.28	0.37	0.37	0.44 J	0.34 J
Cadmium	32.0	1.50	NA	0.022 J	0.031 J	0.017 J	0.018 J	0.032 J	0.046 J	0.033 J	0.033 J	0.031 J
Chromium	64.0	18.2	13	16	12	8.5	4.4	4.3	5.3	5.5	11	12
Cobalt	13.0	9.93	NA	2.5	1.9	1.6	1.1	1.2	1.8	3	2.4	2.6
Copper	70.0	4.25	NA	4.1	2.8	4.8	1.4	1.2	1.5	1.5	2.5	2.7
Cyanide	15.8	--	NA	0.042 B	0.087 J	0.089 J	0.081 J	0.055 B	0.11 B	0.066 J	0.047 J	0.044 J
Iron	5 < pH > 8	19,900	NA	14,000	14,000	8,800	5,300	4,000	5,300	3,800	12,000	14,000
Lead	120	17.4	NA	12	19	31	110	59	21	16	10	11
Manganese	220	324	NA	39	31	29	16	22	35	51	36	36
Mercury	0.10	0.111	NA	0.075	0.046 J	0.066	0.063	0.057	0.048 J	0.038 B	0.05	0.045 B
Nickel	38.0	9.52	NA	4.9	3.8	3.4	2.6	2.8	3.6	3	4	4.3
Selenium	0.52	0.51	NA	0.28	0.21	0.11	0.049 J	0.1	0.15	0.14 B	0.2	0.19
Silver	560	2.10	NA	0.017 J	0.025 J	0.021 J	0.029 J	0.019 J	0.026 J	0.026 J	0.021 J	0.022 J
Thallium	1.00	--	NA	0.14	0.086	0.1	0.089	0.081	0.094	0.063	0.094	0.1
Vanadium	130	27.9	NA	27	24	17	12	8.4	12	7.6	20	23
Zinc	120	26.5	NA	19 B	16	17	12	18 B	17	15 B	14	17
Other Parameters												
pH	--	--	NA	4.90	4.80	4.40	4.60	5.00	5.20	5.40	5.10	NA

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-MW01	CAA06-MW02	
			CAA06-SS27-0913	CAA06-SS28-0913	CAA06-SS29-0913	CAA06-SS30-0913	CAA06-SS31-0913	CAA06-SS32-0913	CAA06-SS33-0913	CAA06-SS34-0913	CAA06-SS35-0913	CAA06-SS35P-0913
			09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13	09/17/13	09/17/13
Total organic carbon (MG/KG)	--	--	NA	15,000	22,000	10,000	12,000	11,000	25,000	8,000	12,000	NA

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

**Bold indicates detections**

NSV - No Screening Value

NA - Not analyzed

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO39
			CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS39-0913
			09/17/13	09/17/13	09/17/13	09/17/13
<b>Semivolatile Organic Compounds (UG/KG)</b>						
Benzaldehyde	58,400	--	NA	NA	NA	NA
Benzo(a)anthracene	HMW PAH	--	NA	NA	NA	NA
Chrysene	HMW PAH	--	NA	NA	NA	NA
Fluoranthene	LMW PAH	--	NA	NA	NA	NA
PAH (HMW)	18,000	--	NA	NA	NA	NA
PAH (LMW)	29,000	--	NA	NA	NA	NA
Pyrene	HMW PAH	--	NA	NA	NA	NA
<b>Explosives (UG/KG)</b>						
1,3,5-Trinitrobenzene	NSV	--	220 U	390 U	400 J	220 U
1,3-Dinitrobenzene	NSV	--	220 U	390 U	220 U	220 U
2,4,6-Trinitrotoluene	10,000	--	910,000	390 U	720,000	220 U
2,4-Dinitrotoluene	11,000	--	1,400	390 U	400 J	220 U
2,6-Dinitrotoluene	8,500	--	220 U	390 U	220 U	220 U
2-Amino-4,6-dinitrotoluene	80,000	--	7,100	390 U	220 U	220 U
2-Nitrotoluene	NSV	--	220 U	390 U	220 U	220 U
3,5-Dinitroaniline	NSV	--	220 U	390 U	220 U	220 U
4-Amino-2,6-dinitrotoluene	80,000	--	4,500	390 U	13,000	220 U
RDX	10,000	--	220 U	390 U	220 U	220 U
Tetryl	10,000	--	220 U	390 U	220 U	220 U
<b>Inorganics (MG/KG)</b>						
Aluminum	pH < 5.5	12,200	6,900	2,700	5,200	3,700
Antimony	78.0	11.0	0.36	0.16 B	0.62	0.15 B
Arsenic	18.0	6.36	3.1	1.6	2.2	1.4
Barium	330	52.9	26	9.4	17	14
Beryllium	40.0	0.587	0.2	0.092 J	0.24	0.24
Cadmium	32.0	1.50	0.061	0.021 J	0.042 J	0.028 J
Chromium	64.0	18.2	8.5 K	3.6	6.4	3.9
Cobalt	13.0	9.93	2.5	0.57	1.7	1
Copper	70.0	4.25	13 K	1.2	2.5	1.3
Cyanide	15.8	--	0.19 B	0.13	0.47	0.08 J
Iron	5 < pH > 8	19,900	8,500	3,900	6,200	4,000
Lead	120	17.4	34	16	170	18
Manganese	220	324	62	12	31	17
Mercury	0.10	0.111	0.089	0.062	0.084	0.038 B
Nickel	38.0	9.52	3.8 K	1.6	3.8	2.4
Selenium	0.52	0.51	0.2	0.24 B	0.32	0.14 B
Silver	560	2.10	0.026 J	0.022 J	0.055	0.028 J
Thallium	1.00	--	0.083	0.058	0.09	0.074
Vanadium	130	27.9	18	12	14	9.7
Zinc	120	26.5	29	7.1	17	8.3
<b>Other Parameters</b>						
pH	--	--	4.60	4.10	4.40	4.80

Table J-20  
Exceedances - AOC 6 TNT Subarea Surface Soil  
Remedial Investigation Report  
*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Soil ESV	Background UTL	CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SO39
			CAA06-SS36-0913	CAA06-SS37-0913	CAA06-SS38-0913	CAA06-SS39-0913
			09/17/13	09/17/13	09/17/13	09/17/13
Total organic carbon (MG/KG)	--	--	17,000	65,000	20,000	19,000

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

Bold indicates detections

NSV - No Screening Value

NA - Not analyzed

Table J-21  
Ecological Screening Statistics - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Semivolatile Organic Compounds (UG/KG)																		
1,1-Biphenyl	360 - 450	0 / 7	--	--	--	193	15.0	--	13,600	-- / --	0.03	NO	--	-- / --	--	--	--	NO
2,2'-Oxybis(1-chloropropane)	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
2,4,5-Trichlorophenol	910 - 1,100	0 / 7	--	--	--	484	31.9	--	1,350	-- / --	0.81	NO	--	-- / --	--	--	--	NO
2,4,6-Trichlorophenol	360 - 450	0 / 7	--	--	--	193	15.0	--	580	-- / --	0.78	NO	--	-- / --	--	--	--	NO
2,4-Dichlorophenol	360 - 450	0 / 7	--	--	--	193	15.0	--	500	-- / --	0.90	NO	--	-- / --	--	--	--	NO
2,4-Dimethylphenol	360 - 450	0 / 7	--	--	--	193	15.0	--	1,000	-- / --	0.45	NO	--	-- / --	--	--	--	NO
2,4-Dinitrophenol	910 - 1,100	0 / 7	--	--	--	484	31.9	--	20,000	-- / --	0.06	NO	--	-- / --	--	--	--	NO
2-Chloronaphthalene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
2-Chlorophenol	360 - 450	0 / 7	--	--	--	193	15.0	--	500	-- / --	0.90	NO	--	-- / --	--	--	--	NO
2-Methylnaphthalene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
2-Methylphenol	360 - 450	0 / 7	--	--	--	193	15.0	--	1,000	-- / --	0.45	NO	--	-- / --	--	--	--	NO
2-Nitroaniline	910 - 1,100	0 / 7	--	--	--	484	31.9	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
2-Nitrophenol	360 - 450	0 / 7	--	--	--	193	15.0	--	1,000	-- / --	0.45	NO	--	-- / --	--	--	--	NO
3,3'-Dichlorobenzidine	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
3-Nitroaniline	910 - 1,100	0 / 7	--	--	--	484	31.9	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4,6-Dinitro-2-methylphenol	910 - 1,100	0 / 7	--	--	--	484	31.9	--	1,000	-- / --	1.10	YES	--	-- / --	--	--	0.48	NO
4-Bromophenyl-phenylether	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Chloro-3-methylphenol	360 - 450	0 / 7	--	--	--	193	15.0	--	500	-- / --	0.90	NO	--	-- / --	--	--	--	NO
4-Chloroaniline	360 - 450	0 / 7	--	--	--	193	15.0	--	500	-- / --	0.90	NO	--	-- / --	--	--	--	NO
4-Chlorophenyl-phenylether	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Methylphenol	360 - 450	0 / 7	--	--	--	193	15.0	--	1,000	-- / --	0.45	NO	--	-- / --	--	--	--	NO
4-Nitroaniline	910 - 1,100	0 / 7	--	--	--	484	31.9	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Nitrophenol	910 - 1,100	0 / 4	--	--	--	491	41.1	--	380	-- / --	2.89	YES	--	-- / --	--	--	1.29	NO <sup>4</sup>
Acenaphthene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Acenaphthylene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Acetophenone	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Anthracene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Atrazine	360 - 450	0 / 7	--	--	--	193	15.0	--	11.9	-- / --	37.8	YES	--	-- / --	--	--	16.2	NO <sup>4</sup>
Benzaldehyde	360 - 450	0 / 7	--	--	--	193	15.0	--	58,400	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Benzo(a)anthracene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(a)pyrene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(b)fluoranthene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(g,h,i)perylene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Benzo(k)fluoranthene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
bis(2-Chloroethoxy)methane	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
bis(2-Chloroethyl)ether	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
bis(2-Ethylhexyl)phthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Butylbenzylphthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Caprolactam	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Carbazole	360 - 450	0 / 7	--	--	--	193	15.0	--	7,000	-- / --	0.06	NO	--	-- / --	--	--	--	NO
Chrysene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO

Table J-21  
Ecological Screening Statistics - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Dibenz(a,h)anthracene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Dibenzofuran	360 - 450	0 / 7	--	--	--	193	15.0	--	4,600	-- / --	0.10	NO	--	-- / --	--	--	--	NO
Diethylphthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	26,800	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Dimethyl phthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	10,640	-- / --	0.04	NO	--	-- / --	--	--	--	NO
Di-n-butylphthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	40,000	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Di-n-octylphthalate	360 - 450	0 / 7	--	--	--	193	15.0	--	30,000	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Fluoranthene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Fluorene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Hexachlorobenzene	360 - 450	0 / 7	--	--	--	193	15.0	--	1,000	-- / --	0.45	NO	--	-- / --	--	--	--	NO
Hexachlorobutadiene	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Hexachlorocyclopentadiene	360 - 450	0 / 7	--	--	--	193	15.0	--	2,000	-- / --	0.23	NO	--	-- / --	--	--	--	NO
Hexachloroethane	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Indeno(1,2,3-cd)pyrene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Isophorone	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Naphthalene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
n-Nitroso-di-n-propylamine	360 - 450	0 / 7	--	--	--	193	15.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
n-Nitrosodiphenylamine	360 - 450	0 / 7	--	--	--	193	15.0	--	1,090	-- / --	0.41	NO	--	-- / --	--	--	--	NO
PAH (HMW)	1,620 - 2,025	0 / 7	--	--	--	868	67.3	--	18,000	-- / --	0.11	NO	--	-- / --	--	--	--	NO
PAH (LMW)	1,620 - 2,025	0 / 7	--	--	--	868	67.3	--	29,000	-- / --	0.07	NO	--	-- / --	--	--	--	NO
Pentachlorophenol	910 - 1,100	0 / 7	--	--	--	484	31.9	--	5,000	-- / --	0.22	NO	--	-- / --	--	--	--	NO
Phenanthrene	360 - 450	0 / 7	--	--	--	193	15.0	--	LMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
Phenol	360 - 450	0 / 7	--	--	--	193	15.0	--	1,880	-- / --	0.24	NO	--	-- / --	--	--	--	NO
Pyrene	360 - 450	0 / 7	--	--	--	193	15.0	--	HMW PAH	-- / --	--	NO	--	-- / --	--	--	--	NO
<b>Explosives (UG/KG)</b>																		
1,3,5-Trinitrobenzene	99.0 - 260	1 / 20	12,000	12,000	CAA06-SO26-0H02-0913	687	2,663	--	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
1,3-Dinitrobenzene	100 - 260	4 / 20	28.0	1,600	CAA06-SB01-1008	250	448	397	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
2,4,6-Trinitrotoluene	100 - 260	8 / 20	1,400	9,300,000	CAA06-SO26-0H02-0913	662,039	2,123,754	1,517,649	10,000	5 / 20	930	<b>YES</b>	--	-- / --	--	152	66.2	<b>YES</b>
2,4-Dinitrotoluene	210 - 450	4 / 20	700	12,000	CAA06-SO26-0H02-0913	871	2,647	2,072	11,000	1 / 20	1.09	<b>YES</b>	--	-- / --	--	0.19	0.08	NO
2,6-Dinitrotoluene	99.0 - 450	0 / 20	--	--	--	137	42.6	--	8,500	-- / --	0.05	NO	--	-- / --	--	--	--	NO
2-Amino-4,6-dinitrotoluene	99.0 - 260	7 / 20	610	15,000	CAA06-SB13-1108	2,264	4,516	--	80,000	0 / 20	0.19	NO	--	-- / --	--	--	--	NO
2-Nitrotoluene	200 - 280	0 / 20	--	--	--	111	12.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
3,5-Dinitroaniline	99.0 - 280	1 / 20	550	550	CAA06-SB13-1108	119	107	--	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
3-Nitrotoluene	200 - 280	0 / 20	--	--	--	111	12.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
4-Amino-2,6-dinitrotoluene	99.0 - 260	6 / 20	340	30,000	CAA06-SB13-1108	2,820	7,107	--	80,000	0 / 20	0.38	NO	--	-- / --	--	--	--	NO
4-Nitrotoluene	200 - 280	1 / 20	3,200	3,200	CAA06-SB36-0H02-0913	265	691	--	NSV	-- / --	NSV	<b>YES</b>	--	-- / --	--	NSV	NSV	<b>YES</b>
HMX	200 - 280	0 / 20	--	--	--	111	12.0	--	10,000	-- / --	0.03	NO	--	-- / --	--	--	--	NO
Nitrobenzene	99.0 - 450	0 / 20	--	--	--	137	42.6	--	2,260	-- / --	0.20	NO	--	-- / --	--	--	--	NO
Nitroglycerin	210 - 5,000	0 / 19	--	--	--	731	913	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Nitroguanidine	10.0 - 130	0 / 7	--	--	--	39.3	32.1	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
PETN	210 - 500	0 / 20	--	--	--	164	65.2	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
RDX	200 - 280	0 / 20	--	--	--	111	12.0	--	10,000	-- / --	0.03	NO	--	-- / --	--	--	--	NO
Tetryl	200 - 280	0 / 20	--	--	--	111	12.0	--	10,000	-- / --	0.03	NO	--	-- / --	--	--	--	NO

Table J-21  
Ecological Screening Statistics - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Background UTL	Frequency of UTL Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Inorganics (MG/KG)																		
Aluminum	-- - --	20 / 20	3,000	23,600	CAA06-SB03-1008	10,553	4,649	12,350	pH < 5.5	11 / 20	--	YES	13,000	6 / 20	1.82	--	--	NO
Antimony	0.070 - 11.0	8 / 20	0.088	0.72	CAA06-SB38-0H02-0913	1.32	1.77	--	78.0	0 / 20	0.01	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	20 / 20	1.40	20.9	CAA06-SB01-1008	5.77	4.81	7.93	18.0	1 / 20	1.16	YES	5.54	6 / 20	3.77	0.44	0.32	NO
Barium	-- - --	20 / 20	13.5	35.9	CAA06-SB03-1008	23.1	6.24	--	330	0 / 20	0.11	NO	--	-- / --	--	--	--	NO
Beryllium	-- - --	20 / 20	0.25	0.73	CAA06-SB01-1008	0.44	0.13	--	40.0	0 / 20	0.02	NO	--	-- / --	--	--	--	NO
Cadmium	0.35 - 0.90	15 / 20	0.013	0.14	CAA06-SO26-0H02-0913	0.095	0.12	--	32.0	0 / 20	0.004	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	20 / 20	69.0	1,800	CAA06-SO26-0H02-0913	507	486	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium (hexavalent)	-- - --	2 / 2	0.31	0.94	CAA06-SB27-0H02-0913	0.63	0.45	--	0.40	1 / 2	2.35	YES	--	-- / --	--	--	1.56	YES
Chromium	-- - --	22 / 22	4.10	36.3	CAA06-SB03-1008	15.3	8.21	--	64.0	0 / 22	0.57	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	20 / 20	1.80	5.00	CAA06-SB03-1008	2.76	0.79	--	13.0	0 / 20	0.38	NO	--	-- / --	--	--	--	NO
Copper	1.50 - 4.80	17 / 20	0.79	8.10	CAA06-SB03-1008	2.96	1.86	--	70.0	0 / 20	0.12	NO	--	-- / --	--	--	--	NO
Cyanide	0.029 - 0.65	6 / 20	0.035	0.54	CAA06-SB13-1108	0.16	0.16	--	15.8	0 / 20	0.03	NO	--	-- / --	--	--	--	NO
Iron	-- - --	20 / 20	3,460	34,700	CAA06-SB01-1008	14,061	8,302	17,271	5 < pH > 8	5 / 20	--	YES	32,000	1 / 20	1.08	Mean pH in range		NO
Lead	-- - --	20 / 20	4.00	470	CAA06-SO26-0H02-0913	38.2	102	138	120	1 / 20	3.92	YES	8.79	14 / 20	53.5	1.15	0.32	YES
Magnesium <sup>3</sup>	-- - --	20 / 20	270	1,410	CAA06-SB03-1008	689	252	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	20 / 20	21.0	130	CAA06-SO26-0H02-0913	45.6	28.7	--	220	0 / 20	0.59	NO	--	-- / --	--	--	--	NO
Mercury	0.020 - 0.14	11 / 20	0.034	0.085	CAA06-SB28-0H02-0913	0.049	0.018	--	0.10	0 / 20	0.85	NO	--	-- / --	--	--	--	NO
Nickel	-- - --	20 / 20	2.60	17.2	CAA06-SB03-1008	5.83	3.09	--	38.0	0 / 20	0.45	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	20 / 20	180	1,630	CAA06-SB03-1008	575	341	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.065 - 2.70	17 / 20	0.17	1.60	CAA06-SB03-1008	0.48	0.45	0.84	0.52	4 / 20	3.08	YES	0.64	3 / 20	2.50	1.62	0.92	YES
Silver	0.69 - 1.80	13 / 20	0.011	0.029	CAA06-SB29-0H02-0913	0.21	0.30	--	560	0 / 20	0.0001	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	12.0 - 33.2	11 / 20	9.60	60.6	CAA06-SB03-1008	18.4	13.7	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.11 - 4.50	14 / 20	0.054	0.17	CAA06-SB36-0H02-0913	0.42	0.69	--	1.00	0 / 20	0.17	NO	--	-- / --	--	--	--	NO
Vanadium	-- - --	20 / 20	6.40	54.2	CAA06-SB03-1008	23.2	10.5	--	130	0 / 20	0.42	NO	--	-- / --	--	--	--	NO
Zinc	20.0 - 66.0	18 / 20	7.60	34.6	CAA06-SB03-1008	20.3	7.75	--	120	0 / 20	0.29	NO	--	-- / --	--	--	--	NO
Other Parameters																		
pH	-- - --	20 / 20	4.30	6.80	CAA06-SB08-1108	5.44	0.66	--	--	-- / --	--	--	--	-- / --	--	--	--	--
Total organic carbon (MG/KG)	-- - --	20 / 20	1,200	22,000	CAA06-SO26-0H02-0913	6,810	5,222	--	--	-- / --	--	--	--	-- / --	--	--	--	--

NSV - No Screening Value  
1 - Count of detected samples exceeding or equaling Screening Value  
2 - Shaded cells indicate hazard quotient based on reporting limits  
3 - Macronutrient - Not considered to be a COPC

Table J-22  
Exceedances - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO01	CAA06-SO02	CAA06-SO03	CAA06-SO04	CAA06-SO07	CAA06-SO08	CAA06-SO13	CAA06-SO26		
			CAA06-SB01-1008	CAA06-SB02-1008	CAA06-SB03-1008	CAA06-SB04-1008	CAA06-SB07-1108	CAA06-SB08-1108	CAA06-SB13-1108	CAA06-SO26-0H02-0913	CAA06-SB26-0H02-0913	CAA06-SB26P-0H02-0913
			10/20/08	10/21/08	10/21/08	10/21/08	11/05/08	11/06/08	11/06/08	09/19/13	09/19/13	09/19/13
Explosives (UG/KG)												
1,3,5-Trinitrobenzene	NSV	--	99 U	100 U	100 U	100 U	100 U	100 U	100 U	12,000	NA	NA
1,3-Dinitrobenzene	NSV	--	1,600 J	100 UJ	28 J	100 U	100 U	100 U	290	1,500	NA	NA
2,4,6-Trinitrotoluene	10,000	--	2,700,000	6,700	1,400	100 U	100 U	100 U	660,000	9,300,000	NA	NA
2,4-Dinitrotoluene	11,000	--	1,700	450 U	380 U	360 U	390 U	370 U	780	12,000	NA	NA
2-Amino-4,6-dinitrotoluene	80,000	--	99 UJ	610 J	650 J	100 U	100 U	100 U	15,000	14,000	NA	NA
3,5-Dinitroaniline	NSV	--	99 U	100 U	100 U	100 U	100 U	100 UJ	550	280 U	NA	NA
4-Amino-2,6-dinitrotoluene	80,000	--	99 U	100 U	340	100 U	100 U	100 U	30,000	12,000	NA	NA
4-Nitrotoluene	NSV	--	200 U	200 U	200 U	200 U	200 U	200 U	200 U	280 U	NA	NA
Inorganics (MG/KG)												
Aluminum	pH < 5.5	13,000	10,400	16,200	23,600	10,400	4,200	9,950	13,400	6,700	NA	NA
Antimony	78.0	--	10 UL	6.8 UL	11 UL	6 UL	4.6 UL	5.8 UL	4.2 UL	0.29	NA	NA
Arsenic	18.0	5.54	20.9 J	9.6 J	14.4 J	6.8 J	2 L	4 L	5.4 L	10	NA	NA
Barium	330	84.5	15.3 J	24.5	35.9	13.5 J	16.4 K	28.8 K	25.4 K	21	NA	NA
Beryllium	40.0	0.52	0.73	0.4 J	0.67	0.48 J	0.37 J	0.34 J	0.42	0.44	NA	NA
Cadmium	32.0	--	0.02 J	0.57 U	0.9 U	0.11 J	0.38 U	0.48 U	0.35 U	0.14	NA	NA
Chromium (hexavalent)	0.40	--	NA	NA	NA	NA	NA	NA	NA	NA	0.27 J	0.31 J
Chromium	64.0	33.7	34.4 L	23.6 L	36.3 L	19.7 L	5.2	12.5	16.3	12	21 J	15 J
Cobalt	13.0	5.18	3.3 J	3.5 J	5 J	2.5 J	2.4 J	1.8 J	2.6 J	2.9	NA	NA
Copper	70.0	3.17	4.3	4.6	8.1	3.9	1.5 B	2.7 B	4.8 B	6	NA	NA
Cyanide	15.8	2.70	0.55 U	0.65 U	0.6 U	0.55 U	0.5 U	0.55 U	0.54 J	0.42	NA	NA
Iron	5 < pH > 8	32,000	34,700 J	15,400 J	25,700 J	17,800 J	3,460	8,260	11,900	31,000	NA	NA
Lead	120	8.79	25 J	10.8 J	16.6 J	6.9 J	4.1	8.7	35.4	470	NA	NA
Manganese	220	176	108	31	37.4	26.5	31.8 L	36.9 L	39.4 L	130	NA	NA
Mercury	0.10	0.14	0.11 UL	0.14 UL	0.11 UL	0.1 UL	0.12 UL	0.086 UL	0.05 L	0.058	NA	NA
Nickel	38.0	17.6	7.2	8.3	17.2	5.6	3.3	5.2	7	4.5	NA	NA
Selenium	0.52	0.64	1.4 J	0.64 J	1.6 J	0.62 J	2.7 U	0.4 J	0.41 J	0.18	NA	NA
Silver	560	1.10	1.7 U	1.1 U	1.8 U	1 U	0.77 U	0.96 U	0.69 U	0.025 J	NA	NA
Thallium	1.00	--	4.2 U	2.8 U	4.5 U	0.07 J	1.9 U	0.12 B	0.11 B	0.092	NA	NA
Vanadium	130	48.3	32.6	33.4	54.2	28.3	6.9	19.1	23.9	21	NA	NA
Zinc	120	28.0	24	24.7	34.6	19.7	7.6 K	16.2 K	20.8 K	66 B	NA	NA
Other Parameters												
pH	--	--	6.00	5.70	6.10	6.10	5.80	6.80	5.30	5.70	NA	NA
Total organic carbon (MG/KG)	--	--	2,600 J	3,200 J	2,200 J	2,500 J	4,700	12,000	5,600	22,000	NA	NA

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

**Bold indicates detections**

NSV - No Screening Value

NA - Not analyzed

Table J-22  
Exceedances - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-SO27	CAA06-SO28	CAA06-SO29	CAA06-SO30	CAA06-SO31	CAA06-SO32	CAA06-SO33	CAA06-MW01
			CAA06-SB27-0H02-0913	CAA06-SB28-0H02-0913	CAA06-SB29-0H02-0913	CAA06-SB30-0H02-0913	CAA06-SB31-0H02-0913	CAA06-SB32-0H02-0913	CAA06-SB33-0H02-0913	CAA06-SB34-0H02-0913
			09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/18/13	09/17/13
Explosives (UG/KG)										
1,3,5-Trinitrobenzene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	210 U
1,3-Dinitrobenzene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	210 U
2,4,6-Trinitrotoluene	10,000	--	NA	230 U	220 U	220 U	1,500	220 U	220 U	210 U
2,4-Dinitrotoluene	11,000	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	210 U
2-Amino-4,6-dinitrotoluene	80,000	--	NA	230 U	220 U	220 U	4,400	220 U	220 U	210 U
3,5-Dinitroaniline	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	210 U
4-Amino-2,6-dinitrotoluene	80,000	--	NA	230 U	220 U	220 U	2,600	220 U	220 U	210 U
4-Nitrotoluene	NSV	--	NA	230 U	220 U	220 U	220 U	220 U	220 U	210 U
Inorganics (MG/KG)										
Aluminum	pH < 5.5	13,000	NA	13,000	9,800	11,000	14,000	8,600	5,000	3,000
Antimony	78.0	--	NA	0.19	0.22	0.14	0.15	0.11	0.088 J	0.07 B
Arsenic	18.0	5.54	NA	4.2	5.2	3.6	4.1	2.3	1.5	1.4
Barium	330	84.5	NA	28	17	24	32	20	23	19
Beryllium	40.0	0.52	NA	0.44	0.33	0.53	0.53	0.28	0.36	0.36
Cadmium	32.0	--	NA	0.016 J	0.029 J	0.033 J	0.034 J	0.025 J	0.023 J	0.022 J
Chromium (hexavalent)	0.40	--	0.94	NA	NA	NA	NA	NA	NA	NA
Chromium	64.0	33.7	18 K	16	14	13	14	9.3	6.1	4.1
Cobalt	13.0	5.18	NA	2.9	2.5	2.5	3.7	2	1.9	2.7
Copper	70.0	3.17	NA	2.6	3.8	2.5	3	1.5	0.92	0.79
Cyanide	15.8	2.70	NA	0.055 U	0.052 B	0.038 B	0.077 J	0.029 B	0.03 B	0.052 U
Iron	5 < pH > 8	32,000	NA	14,000	14,000	13,000	16,000	9,100	4,900	3,900
Lead	120	8.79	NA	10	34	11	17	30	11	4
Manganese	220	176	NA	30	39	27	69	30	31	32
Mercury	0.10	0.14	NA	0.085	0.039 J	0.049 J	0.058	0.052	0.034 J	0.02 B
Nickel	38.0	17.6	NA	5.2	4.7	5.1	7.8	4.1	3.7	2.6
Selenium	0.52	0.64	NA	0.32	0.21	0.26	0.3	0.17	0.2	0.065 B
Silver	560	1.10	NA	0.015 J	0.029 J	0.018 J	0.021 J	0.015 J	0.015 J	0.014 J
Thallium	1.00	--	NA	0.15	0.12	0.14	0.16	0.11	0.11	0.054
Vanadium	130	48.3	NA	27	23	23	28	19	9.9	6.4
Zinc	120	28.0	NA	18	21	24	30	27	14	8.5
Other Parameters										
pH	--	--	NA	5.10	4.80	4.50	5.10	5.20	5.40	5.70
Total organic carbon (MG/KG)	--	--	NA	4,100	17,000	6,000	5,600	5,900	5,900	1,200

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

Bold indicates detections

NSV - No Screening Value

NA - Not analyzed

Table J-22  
Exceedances - AOC 6 TNT Subarea Subsurface Soil  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Soil ESV	Background UTL	CAA06-MW02		CAA06-MW03	CAA06-MW04	CAA06-MW05	CAA06-SQ39
			CAA06-SB35-0H02-0913	CAA06-SB35P-0H02-0913	CAA06-SB36-0H02-0913	CAA06-SB37-0H02-0913	CAA06-SB38-0H02-0913	CAA06-SB39-0H02-0913
			09/17/13	09/17/13	09/17/13	09/17/13	09/17/13	09/17/13
Explosives (UG/KG)								
1,3,5-Trinitrobenzene	NSV	--	230 U	260 U	250 U	240 U	260 U	220 U
1,3-Dinitrobenzene	NSV	--	230 U	260 U	250 U	240 U	260 U	220 U
2,4,6-Trinitrotoluene	10,000	--	230 U	260 U	490,000	240 U	80,000	220 U
2,4-Dinitrotoluene	11,000	--	230 U	260 U	700	240 U	260 U	220 U
2-Amino-4,6-dinitrotoluene	80,000	--	230 U	260 U	3,200	240 U	6,200	220 U
3,5-Dinitroaniline	NSV	--	230 U	260 U	250 U	240 U	260 U	220 U
4-Amino-2,6-dinitrotoluene	80,000	--	230 U	260 U	2,300	240 U	7,900	220 U
4-Nitrotoluene	NSV	--	230 U	260 U	3,200	240 U	260 U	220 U
Inorganics (MG/KG)								
Aluminum	pH < 5.5	13,000	11,000	11,000	15,000	9,500	7,200	9,100
Antimony	78.0	--	0.15 B	0.14 B	0.21 B	0.18 B	0.72	0.13 B
Arsenic	18.0	5.54	3.8	3.8	5.6 L	5.4	2.7	2.4
Barium	330	84.5	32	30	29	17	21	20
Beryllium	40.0	0.52	0.48	0.55	0.63	0.25	0.26	0.37
Cadmium	32.0	--	0.022 J	0.027 J	0.019 J	0.015 J	0.025 J	0.013 J
Chromium (hexavalent)	0.40	--	NA	NA	NA	NA	NA	NA
Chromium	64.0	33.7	13	11	18	13	8.4	9.1
Cobalt	13.0	5.18	3.6	3.3	3.2	2	2.2	2
Copper	70.0	3.17	2.6	2.7	4.1	2.4	1.9	1.5
Cyanide	15.8	2.70	0.054 U	0.055 U	0.084 L	0.035 J	0.21	0.054 U
Iron	5 < pH > 8	32,000	12,000	12,000	17,000	12,000	8,500	8,600
Lead	120	8.79	7.8	7.4	13 L	9.6	33	6.8
Manganese	220	176	62	55	69	27	34	21
Mercury	0.10	0.14	0.044 B	0.049 J	0.055	0.041 B	0.07	0.041 B
Nickel	38.0	17.6	6.1	5.7	6.7	4.2	4.2	3.9
Selenium	0.52	0.64	0.35	0.33	0.36 L	0.35	0.27 B	0.26
Silver	560	1.10	0.02 J	0.023 J	0.026 J	0.02 J	0.011 J	0.018 J
Thallium	1.00	--	0.14	0.13	0.17	0.12	0.1	0.12
Vanadium	130	48.3	23	21	30	22	16	18
Zinc	120	28.0	20 B	18 B	27	16	16	14
Other Parameters								
pH	--	--	6.40	NA	4.30	4.50	5.20	5.00
Total organic carbon (MG/KG)	--	--	4,500	NA	7,700	12,000	6,800	4,700

Notes:

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value ≥ ESV and ≥ background UTL; ≥ ESV and no UTL; ≥ background UTL and no ESV; or detected and no ESV and UTL

**Bold indicates detections**

NSV - No Screening Value

NA - Not analyzed

Table J-23  
Screening Statistics - AOC 6 TNT Subarea Surface Soil - Mammal/Bird Eco-SSLs  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	95% UCL (Norm)	Arithmetic Mean	Mammal Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient	Bird Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient
Inorganics (MG/KG)															
Arsenic	-- - --	20 / 20	11.8	--	3.87	46.0	0 / 20	0.26	--	--	43.0	0 / 20	0.27	--	--
Cadmium	0.020 - 0.38	17 / 20	0.29	--	0.06	0.36	0 / 20	0.81	--	--	0.77	0 / 20	0.38	--	--
Chromium	-- - --	22 / 22	34.7	13.6	11.0	34.0	1 / 22	1.02	0.40	0.32	26.0	1 / 22	1.33	0.52	0.42
Copper	2.20 - 4.80	17 / 20	13.0	--	3.94	49.0	0 / 20	0.27	--	--	28.0	0 / 20	0.46	--	--
Lead	-- - --	20 / 20	1,100	379	123	56.0	7 / 20	19.6	6.76	2.19	11.0	18 / 20	100	34.4	11.1
Nickel	-- - --	20 / 20	10.1	--	4.63	130	0 / 20	0.08	--	--	210	0 / 20	0.05	--	--
Selenium	0.14 - 4.30	14 / 20	2.00	0.55	0.56	0.63	2 / 20	3.17	0.87	0.89	1.20	1 / 20	1.67	0.45	0.47
Silver	0.67 - 2.30	13 / 20	0.055	--	0.21	14.0	0 / 20	0.004	--	--	4.20	0 / 20	0.01	--	--
Zinc	15.0 - 19.0	17 / 20	176	78.7	34.4	79.0	3 / 20	2.23	0.996	0.44	46.0	4 / 20	3.83	1.71	0.75
Semivolatile Organic Compounds (UG/KG)															
PAH (HMW)	1,665 - 2,070	1 / 7	2,070	--	1,067	1,100	1 / 7	1.88	--	0.97	--	-- - --	--	--	--
PAH (LMW)	1,665 - 2,070	1 / 7	1,940	--	1,049	100,000	0 / 7	0.02	--	--	--	-- - --	--	--	--
Pentachlorophenol <sup>1</sup>	940 - 1,200	0 / 7	--	--	506	2,800	-- / --	0.43	--	--	2,100	-- / --	0.57	--	--

Shaded cells indicate HQ ≥ 1  
1 - HQs based upon reporting limits

Table J-24  
Summary of Hazard Quotients for Food Web Exposures - Screening (Step 2) - Maximum  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Meadow Vole			Short-tailed Shrew			White-footed Mouse			Red Fox			American Robin (Omnivore)			American Robin (Invertivore)			Mourning Dove			Red-tailed Hawk		
	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL
Metals																								
Chromium	2.52E-01	1.13E-01	5.03E-02	5.61E+00	2.51E+00	1.12E+00	1.17E+00	5.21E-01	2.33E-01	1.36E-01	6.09E-02	2.72E-02	2.22E+00	9.91E-01	4.43E-01	3.21E+00	1.44E+00	6.43E-01	3.37E-01	1.51E-01	6.75E-02	4.89E-02	2.19E-02	9.79E-03
Lead	9.64E-01	7.00E-01	5.09E-01	1.00E+01	7.28E+00	5.29E+00	1.51E+00	1.10E+00	7.97E-01	6.79E-01	4.93E-01	3.58E-01	4.73E+00	2.12E+00	9.47E-01	5.62E+00	2.51E+00	1.12E+00	8.28E+00	5.86E+00	4.14E+00	3.72E-01	1.67E-01	7.45E-02
Mercury	5.61E-01	2.51E-01	1.12E-01	9.88E+00	4.42E+00	1.98E+00	2.15E+00	9.63E-01	4.31E-01	3.40E-02	2.64E-02	2.04E-02	2.92E-01	1.87E-01	1.19E-01	4.21E-01	2.69E-01	1.72E-01	5.41E-02	3.83E-02	2.71E-02	2.13E-03	1.36E-03	8.71E-04
Selenium	6.57E-01	5.11E-01	3.98E-01	1.18E+00	9.20E-01	7.17E-01	4.56E-01	3.55E-01	2.77E-01	2.38E-01	1.85E-01	1.44E-01	3.66E-01	1.98E-01	1.07E-01	3.02E-01	1.64E-01	8.86E-02	8.00E-01	5.66E-01	4.01E-01	8.60E-02	4.66E-02	2.52E-02
Zinc	1.30E-01	5.81E-02	2.60E-02	7.72E-01	3.45E-01	1.54E-01	1.83E-01	8.19E-02	3.66E-02	8.28E-02	3.70E-02	1.66E-02	4.47E-01	2.00E-01	8.95E-02	5.51E-01	2.47E-01	1.10E-01	2.70E-01	1.21E-01	5.40E-02	7.87E-02	3.52E-02	1.57E-02
Semivolatile Organics																								
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.07E-02	4.77E-03	2.13E-03	1.49E-02	6.68E-03	2.99E-03	1.27E-02	5.68E-03	2.54E-03	2.50E-03	1.12E-03	5.01E-04	7.31E-04	3.27E-04	1.46E-04	6.64E-04	2.97E-04	1.33E-04	8.67E-04	3.88E-04	1.73E-04	1.00E-04	4.47E-05	2.00E-05
Benzo(a)pyrene	1.69E-02	7.56E-03	3.38E-03	4.13E-02	1.85E-02	8.27E-03	1.82E-02	8.17E-03	3.65E-03	3.42E-03	1.53E-03	6.85E-04	1.87E-03	8.34E-04	3.73E-04	1.84E-03	8.22E-04	3.68E-04	2.04E-03	9.12E-04	4.08E-04	1.00E-04	4.47E-05	2.00E-05
Benzo(b)fluoranthene	3.75E-02	1.68E-02	7.51E-03	3.36E-02	1.50E-02	6.72E-03	2.19E-02	9.80E-03	4.39E-03	4.00E-03	1.79E-03	8.02E-04	2.62E-03	1.17E-03	5.24E-04	1.32E-03	5.90E-04	2.64E-04	5.48E-03	2.45E-03	1.10E-03	1.00E-04	4.47E-05	2.00E-05
Benzo(g,h,i)perylene	2.84E-02	1.27E-02	5.69E-03	2.87E-02	1.29E-02	5.76E-03	1.86E-02	8.33E-03	3.73E-03	3.66E-03	1.64E-03	7.33E-04	1.99E-03	8.89E-04	3.97E-04	1.08E-03	4.82E-04	2.16E-04	3.99E-03	1.78E-03	7.98E-04	1.00E-04	4.47E-05	2.00E-05
Benzo(k)fluoranthene	1.69E-02	7.55E-03	3.38E-03	3.22E-02	1.44E-02	6.44E-03	1.64E-02	7.33E-03	3.28E-03	3.32E-03	1.49E-03	6.65E-04	1.53E-03	6.85E-04	3.06E-04	1.32E-03	5.90E-04	2.64E-04	2.06E-03	9.23E-04	4.13E-04	1.00E-04	4.47E-05	2.00E-05
Chrysene	1.15E-02	5.15E-03	2.31E-03	2.31E-02	1.03E-02	4.62E-03	1.44E-02	6.42E-03	2.88E-03	2.68E-03	1.20E-03	5.38E-04	1.05E-03	4.69E-04	2.10E-04	1.08E-03	4.82E-04	2.15E-04	1.02E-03	4.56E-04	2.04E-04	1.00E-04	4.47E-05	2.00E-05
Dibenz(a,h)anthracene	2.30E-02	1.03E-02	4.60E-03	5.22E-02	2.34E-02	1.05E-02	2.20E-02	9.86E-03	4.41E-03	3.73E-03	1.67E-03	7.47E-04	2.57E-03	1.15E-03	5.14E-04	2.44E-03	1.09E-03	4.88E-04	3.02E-03	1.35E-03	6.04E-04	1.00E-04	4.47E-05	2.00E-05
Hexachlorobenzene	7.82E-03	5.53E-03	3.91E-03	4.20E-02	2.97E-02	2.10E-02	1.23E-02	8.68E-03	6.13E-03	8.32E-03	5.88E-03	4.16E-03	3.63E-01	1.62E-01	7.26E-02	4.55E-01	2.03E-01	9.10E-02	2.00E-01	8.94E-02	4.00E-02	1.30E-01	5.80E-02	2.59E-02
Hexachlorobutadiene	1.54E-02	4.87E-03	1.54E-03	2.76E-02	8.73E-03	2.76E-03	1.13E-02	3.56E-03	1.13E-03	7.84E-03	2.48E-03	7.84E-04	1.11E-02	4.97E-03	2.22E-03	9.38E-03	4.19E-03	1.88E-03	1.55E-02	6.94E-03	3.10E-03	3.98E-03	1.78E-03	7.97E-04
Hexachlorocyclopentadiene	2.73E-04	1.22E-04	5.46E-05	7.27E-04	3.25E-04	1.45E-04	2.63E-04	1.18E-04	5.27E-05	1.76E-04	7.88E-05	3.52E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	5.87E-04	2.62E-04	1.17E-04	5.71E-04	2.55E-04	1.14E-04	3.00E-04	1.34E-04	6.00E-05	2.24E-04	1.00E-04	4.48E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.81E-02	8.11E-03	3.63E-03	4.63E-02	2.07E-02	9.27E-03	1.96E-02	8.76E-03	3.92E-03	3.51E-03	1.57E-03	7.03E-04	2.11E-03	9.44E-04	4.22E-04	2.12E-03	9.47E-04	4.24E-04	2.23E-03	9.98E-04	4.46E-04	1.00E-04	4.47E-05	2.00E-05
Pyrene	2.34E-01	1.05E-01	4.68E-02	8.12E-02	3.63E-02	1.63E-02	8.04E-02	3.60E-02	1.61E-02	1.12E-02	5.01E-03	2.24E-03	1.41E-02	6.32E-03	2.82E-03	3.03E-03	1.36E-03	6.07E-04	3.81E-02	1.70E-02	7.62E-03	1.00E-04	4.47E-05	2.00E-05

Shaded cells indicate HQ ≥ 1

Table J-25  
Summary of Hazard Quotients for Food Web Exposures - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Meadow Vole			Short-tailed Shrew			White-footed Mouse			Red Fox			American Robin (Omnivore)			American Robin (Invertivore)			Mourning Dove			Red-tailed Hawk		
	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL
Metals																								
Chromium	2.02E-02	9.01E-03	4.03E-03	2.00E-01	8.92E-02	3.99E-02	2.73E-02	1.22E-02	5.46E-03	2.46E-02	1.10E-02	4.93E-03	7.61E-02	3.40E-02	1.52E-02	8.98E-02	4.01E-02	1.80E-02	6.37E-02	2.85E-02	1.27E-02	1.92E-02	8.59E-03	3.84E-03
Lead	1.89E-01	1.37E-01	9.96E-02	2.44E+00	1.77E+00	1.29E+00	2.91E-01	2.11E-01	1.54E-01	2.05E-01	1.49E-01	1.08E-01	1.18E+00	5.26E-01	2.35E-01	1.42E+00	6.33E-01	2.83E-01	2.21E+00	1.57E+00	1.11E+00	1.70E-01	7.61E-02	3.40E-02
Mercury	1.42E-01	6.35E-02	2.84E-02	2.54E-01	1.14E-01	5.08E-02	7.13E-02	3.19E-02	1.43E-02	3.33E-03	2.58E-03	2.00E-03	1.35E-02	8.63E-03	5.52E-03	9.43E-03	6.02E-03	3.85E-03	2.84E-02	2.01E-02	1.42E-02	3.68E-04	2.35E-04	1.50E-04
Selenium	1.03E-01	8.05E-02	6.27E-02	2.92E-01	2.28E-01	1.77E-01	1.03E-01	8.04E-02	6.26E-02	9.22E-02	7.18E-02	5.59E-02	7.89E-02	4.27E-02	2.31E-02	7.77E-02	4.21E-02	2.28E-02	1.45E-01	1.03E-01	7.28E-02	4.27E-02	2.31E-02	1.25E-02

Shaded cells indicate HQ ≥ 1

Table J-26  
Summary of Hazard Quotients for Food Web Exposures - Baseline (Step 3A) - Mean  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Meadow Vole			Short-tailed Shrew			White-footed Mouse			Red Fox			American Robin (Omnivore)			American Robin (Invertivore)			Mourning Dove			Red-tailed Hawk		
	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL
Metals																								
Chromium	1.60E-02	7.17E-03	3.20E-03	1.61E-01	7.20E-02	3.22E-02	2.17E-02	9.70E-03	4.34E-03	2.06E-02	9.22E-03	4.12E-03	6.13E-02	2.74E-02	1.23E-02	7.24E-02	3.24E-02	1.45E-02	5.13E-02	2.30E-02	1.03E-02	1.64E-02	7.31E-03	3.27E-03
Lead	7.80E-02	5.67E-02	4.12E-02	9.08E-01	6.60E-01	4.80E-01	1.17E-01	8.47E-02	6.16E-02	9.70E-02	7.05E-02	5.12E-02	4.58E-01	2.05E-01	9.15E-02	5.52E-01	2.47E-01	1.10E-01	8.41E-01	5.95E-01	4.21E-01	9.73E-02	4.35E-02	1.95E-02
Mercury	1.28E-01	5.73E-02	2.56E-02	2.13E-01	9.54E-02	4.27E-02	6.16E-02	2.76E-02	1.23E-02	2.84E-03	2.20E-03	1.71E-03	1.18E-02	7.54E-03	4.82E-03	7.89E-03	5.04E-03	3.22E-03	2.57E-02	1.82E-02	1.29E-02	3.01E-04	1.92E-04	1.23E-04
Selenium	8.73E-02	6.79E-02	5.29E-02	2.79E-01	2.17E-01	1.69E-01	7.83E-02	6.09E-02	4.74E-02	8.57E-02	6.67E-02	5.19E-02	7.52E-02	4.07E-02	2.21E-02	7.37E-02	3.99E-02	2.16E-02	1.43E-01	1.01E-01	7.14E-02	4.09E-02	2.21E-02	1.20E-02

Shaded cells indicate HQ ≥ 1

Table J-27  
Ecological Screening Statistics - AOC 6 TNT Subarea Groundwater (Site Wells)  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Maximum Upgradient Concentration	Frequency of Upgradient Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
FRESHWATER ESVs																		
Inorganics (UG/L)																		
Aluminum	50.0 - 50.0	2 / 4	19.0	48.0	CAA06-GW03-1013	29.3	12.8	--	87.0	0 / 4	0.55	NO	--	-- / --	--	--	--	NO
Antimony	0.50 - 0.50	0 / 4	--	--	--	0.25	0.0	--	30.0	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	4 / 4	16.0	33.0	CAA06-GW03-1013	24.0	7.26	--	150	0 / 4	0.22	NO	--	-- / --	--	--	--	NO
Barium	-- - --	4 / 4	8.90	25.0	CAA06-GW04-1013	14.5	7.17	--	4.00	4 / 4	6.25	YES	15.0	1 / 4	1.67	--	3.62	YES
Beryllium	0.40 - 0.40	0 / 4	--	--	--	0.20	0.0	--	0.66	-- / --	0.61	NO	--	-- / --	--	--	--	NO
Cadmium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.27	-- / --	0.37	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	4 / 4	15,000	47,000	CAA06-GW04-1013	37,000	14,787	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium	0.44 - 0.59	0 / 4	--	--	--	0.25	0.031	--	11.4	-- / --	0.05	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	4 / 4	0.73	1.90	CAA06-GW02-1013	1.11	0.54	--	23.0	0 / 4	0.08	NO	--	-- / --	--	--	--	NO
Copper	0.15 - 0.51	0 / 4	--	--	--	0.14	0.080	--	9.33	-- / --	0.05	NO	--	-- / --	--	--	--	NO
Cyanide	4.00 - 4.00	1 / 4	15.6	15.6	CAA06-GW05-1013	5.40	6.80	--	5.20	1 / 4	3.00	YES	--	-- / --	--	--	1.04	YES
Iron	-- - --	4 / 4	19,000	36,000	CAA06-GW02-1013	27,750	7,676	--	1,000	4 / 4	36.0	YES	30,000	2 / 4	1.20	--	27.8	YES
Lead	0.50 - 0.50	1 / 4	0.19	0.19	CAA06-GW03-1013	0.24	0.030	--	3.18	0 / 4	0.06	NO	--	-- / --	--	--	--	NO
Magnesium <sup>3</sup>	-- - --	4 / 4	2,100	3,200	CAA06-GW04-1013	2,600	469	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	4 / 4	210	400	CAA06-GW04-1013	298	96.7	--	120	4 / 4	3.33	YES	710	0 / 4	0.56	--	--	NO
Mercury	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.91	-- / --	0.11	NO	--	-- / --	--	--	--	NO
Nickel	-- - --	4 / 4	0.46	2.30	CAA06-GW04-1013	1.06	0.87	--	52.2	0 / 4	0.04	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	4 / 4	1,700	2,800	CAA06-GW04-1013	2,275	479	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.44 - 1.00	0 / 4	--	--	--	0.31	0.13	--	5.00	-- / --	0.20	NO	--	-- / --	--	--	--	NO
Silver	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.36	-- / --	0.28	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	-- - --	4 / 4	8,000	12,000	CAA06-GW04-1013	9,925	1,640	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.033 - 0.10	0 / 4	--	--	--	0.025	0.016	--	12.0	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Vanadium	0.094 - 0.24	0 / 4	--	--	--	0.083	0.032	--	20.0	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Zinc	2.20 - 5.70	0 / 4	--	--	--	2.15	0.84	--	120	-- / --	0.05	NO	--	-- / --	--	--	--	NO
Dissolved Metals (UG/L)																		
Aluminum	50.0 - 50.0	0 / 4	--	--	--	25.0	0.0	--	87.0	-- / --	0.57	NO	--	-- / --	--	--	--	NO
Antimony	0.33 - 0.50	0 / 4	--	--	--	0.23	0.042	--	30.0	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	4 / 4	17.0	25.0	CAA06-GW03-1013	21.0	3.37	--	150	0 / 4	0.17	NO	--	-- / --	--	--	--	NO
Barium	-- - --	4 / 4	7.50	26.0	CAA06-GW04-1013	13.9	8.29	--	4.00	4 / 4	6.50	YES	15.0	1 / 4	1.73	--	3.47	YES
Beryllium	0.40 - 0.40	0 / 4	--	--	--	0.20	0.0	--	0.66	-- / --	0.61	NO	--	-- / --	--	--	--	NO
Cadmium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.25	-- / --	0.41	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	4 / 4	17,000	47,000	CAA06-GW04-1013	36,000	13,191	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium	0.50 - 0.81	0 / 4	--	--	--	0.29	0.078	--	11.0	-- / --	0.07	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	4 / 4	0.62	1.60	CAA06-GW02-1013	1.00	0.45	--	23.0	0 / 4	0.07	NO	--	-- / --	--	--	--	NO
Copper	0.31 - 0.76	0 / 4	--	--	--	0.28	0.10	--	8.96	-- / --	0.08	NO	--	-- / --	--	--	--	NO
Iron	-- - --	4 / 4	19,000	37,000	CAA06-GW02-1013	27,000	7,832	--	1,000	4 / 4	37.0	YES	30,000	1 / 4	1.23	--	27.0	YES
Lead	0.50 - 0.50	0 / 4	--	--	--	0.25	0.0	--	2.52	-- / --	0.20	NO	--	-- / --	--	--	--	NO
Magnesium <sup>3</sup>	-- - --	4 / 4	2,100	3,300	CAA06-GW04-1013	2,600	529	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	4 / 4	170	410	CAA06-GW04-1013	265	107	--	120	4 / 4	3.42	YES	700	0 / 4	0.59	--	--	NO

Table J-27  
Ecological Screening Statistics - AOC 6 TNT Subarea Groundwater (Site Wells)  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Maximum Upgradient Concentration	Frequency of Upgradient Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Mercury	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.77	-- / --	0.13	NO	--	-- / --	--	--	--	NO
Nickel	0.50 - 0.50	2 / 4	0.60	1.60	CAA06-GW04-1013	0.68	0.64	--	52.0	0 / 4	0.03	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	4 / 4	1,800	2,800	CAA06-GW04-1013	2,225	465	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.42 - 1.00	0 / 4	--	--	--	0.39	0.14	--	4.61	-- / --	0.22	NO	--	-- / --	--	--	--	NO
Silver	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.36	-- / --	0.28	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	-- - --	4 / 4	8,700	11,000	CAA06-GW04-1013	9,750	954	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	12.0	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Vanadium	0.071 - 0.20	0 / 4	--	--	--	0.071	0.034	--	20.0	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Zinc	2.30 - 8.40	0 / 4	--	--	--	2.45	1.27	--	118	-- / --	0.07	NO	--	-- / --	--	--	--	NO
MARINE ESVs																		
Inorganics (UG/L)																		
Aluminum	50.0 - 50.0	2 / 4	19.0	48.0	CAA06-GW03-1013	29.3	12.8	--	NSV	-- / --	NSV	YES	--	-- / --	--	NSV	NSV	NO
Antimony	0.50 - 0.50	0 / 4	--	--	--	0.25	0.0	--	500	-- / --	0.001	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	4 / 4	16.0	33.0	CAA06-GW03-1013	24.0	7.26	--	36.0	0 / 4	0.92	NO	--	-- / --	--	--	--	NO
Barium	-- - --	4 / 4	8.90	25.0	CAA06-GW04-1013	14.5	7.17	--	200	0 / 4	0.13	NO	--	-- / --	--	--	--	NO
Beryllium	0.40 - 0.40	0 / 4	--	--	--	0.20	0.0	--	100	-- / --	0.004	NO	--	-- / --	--	--	--	NO
Cadmium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	8.85	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	4 / 4	15,000	47,000	CAA06-GW04-1013	37,000	14,787	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium	0.44 - 0.59	0 / 4	--	--	--	0.25	0.031	--	50.4	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	4 / 4	0.73	1.90	CAA06-GW02-1013	1.11	0.54	--	NSV	-- / --	NSV	YES	8.70	0 / 4	0.22	--	--	NO
Copper	0.15 - 0.51	0 / 4	--	--	--	0.14	0.080	--	3.73	-- / --	0.14	NO	--	-- / --	--	--	--	NO
Cyanide	4.00 - 4.00	1 / 4	15.6	15.6	CAA06-GW05-1013	5.40	6.80	--	1.00	1 / 4	15.6	YES	--	-- / --	--	--	5.40	YES
Iron	-- - --	4 / 4	19,000	36,000	CAA06-GW02-1013	27,750	7,676	--	NSV	-- / --	NSV	YES	30,000	2 / 4	1.20	NSV	NSV	YES
Lead	0.50 - 0.50	1 / 4	0.19	0.19	CAA06-GW03-1013	0.24	0.030	--	8.52	0 / 4	0.02	NO	--	-- / --	--	--	--	NO
Magnesium <sup>3</sup>	-- - --	4 / 4	2,100	3,200	CAA06-GW04-1013	2,600	469	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	4 / 4	210	400	CAA06-GW04-1013	298	96.7	--	100	4 / 4	4.00	YES	710	0 / 4	0.56	--	--	NO
Mercury	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	1.11	-- / --	0.09	NO	--	-- / --	--	--	--	NO
Nickel	-- - --	4 / 4	0.46	2.30	CAA06-GW04-1013	1.06	0.87	--	8.28	0 / 4	0.28	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	4 / 4	1,700	2,800	CAA06-GW04-1013	2,275	479	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.44 - 1.00	0 / 4	--	--	--	0.31	0.13	--	71.1	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Silver	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.23	-- / --	0.43	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	-- - --	4 / 4	8,000	12,000	CAA06-GW04-1013	9,925	1,640	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.033 - 0.10	0 / 4	--	--	--	0.025	0.016	--	21.3	-- / --	0.005	NO	--	-- / --	--	--	--	NO
Vanadium	0.094 - 0.24	0 / 4	--	--	--	0.083	0.032	--	50.0	-- / --	0.005	NO	--	-- / --	--	--	--	NO
Zinc	2.20 - 5.70	0 / 4	--	--	--	2.15	0.84	--	85.6	-- / --	0.07	NO	--	-- / --	--	--	--	NO
Dissolved Metals (UG/L)																		
Aluminum	50.0 - 50.0	0 / 4	--	--	--	25.0	0.0	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Antimony	0.33 - 0.50	0 / 4	--	--	--	0.23	0.042	--	500	-- / --	0.001	NO	--	-- / --	--	--	--	NO
Arsenic	-- - --	4 / 4	17.0	25.0	CAA06-GW03-1013	21.0	3.37	--	36.0	0 / 4	0.69	NO	--	-- / --	--	--	--	NO
Barium	-- - --	4 / 4	7.50	26.0	CAA06-GW04-1013	13.9	8.29	--	200	0 / 4	0.13	NO	--	-- / --	--	--	--	NO
Beryllium	0.40 - 0.40	0 / 4	--	--	--	0.20	0.0	--	100	-- / --	0.004	NO	--	-- / --	--	--	--	NO

Table J-27  
Ecological Screening Statistics - AOC 6 TNT Subarea Groundwater (Site Wells)  
Remedial Investigation Report  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL	Ecological Screening Value	Frequency of Exceedance <sup>1</sup>	Maximum Hazard Quotient <sup>2</sup>	Step 2 COPC?	Maximum Upgradient Concentration	Frequency of Upgradient Exceedance	Maximum Ratio	95% UCL Hazard Quotient	Mean Hazard Quotient	COPC for Risk Evaluation?
Cadmium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	8.80	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Calcium <sup>3</sup>	-- - --	4 / 4	17,000	47,000	CAA06-GW04-1013	36,000	13,191	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Chromium	0.50 - 0.81	0 / 4	--	--	--	0.29	0.078	--	50.0	-- / --	0.02	NO	--	-- / --	--	--	--	NO
Cobalt	-- - --	4 / 4	0.62	1.60	CAA06-GW02-1013	1.00	0.45	--	NSV	-- / --	NSV	YES	8.70	0 / 4	0.18	--	--	NO
Copper	0.31 - 0.76	0 / 4	--	--	--	0.28	0.10	--	3.10	-- / --	0.25	NO	--	-- / --	--	--	--	NO
Iron	-- - --	4 / 4	19,000	37,000	CAA06-GW02-1013	27,000	7,832	--	NSV	-- / --	NSV	YES	30,000	1 / 4	1.23	NSV	NSV	YES
Lead	0.50 - 0.50	0 / 4	--	--	--	0.25	0.0	--	8.10	-- / --	0.06	NO	--	-- / --	--	--	--	NO
Magnesium <sup>3</sup>	-- - --	4 / 4	2,100	3,300	CAA06-GW04-1013	2,600	529	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Manganese	-- - --	4 / 4	170	410	CAA06-GW04-1013	265	107	--	100	4 / 4	4.10	YES	700	0 / 4	0.59	--	--	NO
Mercury	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.94	-- / --	0.11	NO	--	-- / --	--	--	--	NO
Nickel	0.50 - 0.50	2 / 4	0.60	1.60	CAA06-GW04-1013	0.68	0.64	--	8.20	0 / 4	0.20	NO	--	-- / --	--	--	--	NO
Potassium <sup>3</sup>	-- - --	4 / 4	1,800	2,800	CAA06-GW04-1013	2,225	465	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Selenium	0.42 - 1.00	0 / 4	--	--	--	0.39	0.14	--	71.0	-- / --	0.01	NO	--	-- / --	--	--	--	NO
Silver	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	0.23	-- / --	0.43	NO	--	-- / --	--	--	--	NO
Sodium <sup>3</sup>	-- - --	4 / 4	8,700	11,000	CAA06-GW04-1013	9,750	954	--	NSV	-- / --	NSV	NO	--	-- / --	--	--	--	NO
Thallium	0.10 - 0.10	0 / 4	--	--	--	0.050	0.0	--	21.3	-- / --	0.005	NO	--	-- / --	--	--	--	NO
Vanadium	0.071 - 0.20	0 / 4	--	--	--	0.071	0.034	--	50.0	-- / --	0.004	NO	--	-- / --	--	--	--	NO
Zinc	2.30 - 8.40	0 / 4	--	--	--	2.45	1.27	--	81.0	-- / --	0.10	NO	--	-- / --	--	--	--	NO

NSV - No Screening Value  
1 - Count of detected samples exceeding or equaling Screening Value  
2 - Shaded cells indicate hazard quotient based on reporting limits  
3 - Macronutrient - Not considered to be a COPC

Table J-28

Exceedances - AOC 6 TNT Subarea Groundwater (Site Wells)

Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Surface Water ESV	Maximum Upgradient Concentration	CAA06-MW02	CAA06-MW03	CAA06-MW04	CAA06-MW05
			CAA06-GW02-1013	CAA06-GW03-1013	CAA06-GW04-1013	CAA06-GW05-1013
			10/02/13	10/02/13	10/02/13	10/02/13
FRESHWATER ESVs						
Inorganics (UG/L)						
Aluminum	87.0	--	19 J	48 J	50 U	50 U
Arsenic	150	33.0	21	33	16	26
Barium	4.00	15.0	12	8.9	25	12
Cobalt	23.0	8.70	1.9	0.73 J	1.00	0.80 J
Cyanide	5.20	--	4 U	4 U	4 U	15.6
Iron	1,000	30,000	36,000 J	32,000	19,000	24,000
Lead	3.18	--	0.5 U	0.19 J	0.5 U	0.5 U
Manganese	120	710	220	210	400	360
Nickel	52.2	1.10	1.0	0.46 J	2.3	0.47 J
Dissolved Metals (UG/L)						
Arsenic	150	32.0	20	25	17	22
Barium	4.00	15.0	12	7.5	26	10
Cobalt	23.0	8.70	1.6	0.62 J	1.1	0.68 J
Iron	1,000	30,000	37,000 J	29,000	19,000	23,000
Manganese	120	700	200	170	410	280
Nickel	52.0	1.20	0.6 J	0.5 U	1.6	0.5 U
MARINE ESVs						
Inorganics (UG/L)						
Aluminum	NSV	--	19 J	48 J	50 U	50 U
Arsenic	36.0	33.0	21	33	16	26
Barium	200	15.0	12	8.9	25	12
Cobalt	NSV	8.70	1.9	0.73 J	1.00	0.80 J
Cyanide	1.00	--	4 U	4 U	4 U	15.6
Iron	NSV	30,000	36,000 J	32,000	19,000	24,000
Lead	8.52	--	0.5 U	0.19 J	0.5 U	0.5 U
Manganese	100	710	220	210	400	360
Nickel	8.28	1.10	1.0	0.46 J	2.3	0.47 J

Table J-28

Exceedances - AOC 6 TNT Subarea Groundwater (Site Wells)

Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Surface Water ESV	Maximum Upgradient Concentration	CAA06-MW02	CAA06-MW03	CAA06-MW04	CAA06-MW05
			CAA06-GW02-1013	CAA06-GW03-1013	CAA06-GW04-1013	CAA06-GW05-1013
			10/02/13	10/02/13	10/02/13	10/02/13
<b>Dissolved Metals (UG/L)</b>						
Arsenic	36.0	32.0	20	25	17	22
Barium	200	15.0	12	7.5	26	10
Cobalt	NSV	8.70	1.6	0.62 J	1.1	0.68 J
Iron	NSV	30,000	37,000 J	29,000	19,000	23,000
Manganese	100	700	200	170	410	280
Nickel	8.20	1.20	0.6 J	0.5 U	1.6	0.5 U

**Notes:**

Grey highlighting indicates value greater than ESV

Yellow highlighting indicates value equal to ESV

Red highlighting indicates value  $\geq$  ESV and  $\geq$  maximum upgradient concentration;  $\geq$  ESV and no upgradient value;  $\geq$  maximum upgradient value and no ESV; or detected and no ESV and upgradient value

Bold indicates detections

NA - Not analyzed

Table J-29

## Summary Statistics - AOC 6 TNT Subarea Groundwater - Upgradient Wells

## Remedial Investigation Report

Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean
<b>Inorganics (UG/L)</b>							
Aluminum	50.0 - 50.0	0 / 2	--	--	--	25.0	0.0
Antimony	0.29 - 0.50	0 / 2	--	--	--	0.20	0.074
Arsenic	-- - --	2 / 2	6.30	33.0	CAA06-GW06-1013	19.7	18.9
Barium	-- - --	2 / 2	14.0	15.0	CAA06-GW01-1013	14.5	0.71
Beryllium	0.40 - 0.40	0 / 2	--	--	--	0.20	0.0
Cadmium	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Calcium	-- - --	2 / 2	22,000	38,000	CAA06-GW06-1013	30,000	11,314
Chromium	0.50 - 1.20	0 / 2	--	--	--	0.43	0.25
Cobalt	-- - --	2 / 2	0.56	8.70	CAA06-GW01-1013	4.63	5.76
Copper	0.38 - 0.50	0 / 2	--	--	--	0.22	0.042
Cyanide	4.00 - 4.00	0 / 2	--	--	--	2.00	0.0
Iron	-- - --	2 / 2	16,000	30,000	CAA06-GW06-1013	23,000	9,899
Lead	0.50 - 0.50	0 / 2	--	--	--	0.25	0.0
Magnesium	-- - --	2 / 2	2,800	3,600	CAA06-GW01-1013	3,200	566
Manganese	-- - --	2 / 2	340	710	CAA06-GW01-1013	525	262
Mercury	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Nickel	-- - --	2 / 2	0.75	1.10	CAA06-GW01-1013	0.93	0.25
Potassium	-- - --	2 / 2	1,600	2,600	CAA06-GW06-1013	2,100	707
Selenium	0.45 - 1.00	0 / 2	--	--	--	0.36	0.19
Silver	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Sodium	-- - --	2 / 2	7,900	9,600	CAA06-GW06-1013	8,750	1,202
Thallium	0.044 - 0.054	0 / 2	--	--	--	0.025	0.0035
Vanadium	0.14 - 0.20	0 / 2	--	--	--	0.085	0.021
Zinc	3.20 - 8.70	0 / 2	--	--	--	2.98	1.94
<b>Dissolved Metals (UG/L)</b>							
Aluminum	50.0 - 50.0	0 / 2	--	--	--	25.0	0.0
Antimony	0.50 - 0.50	0 / 2	--	--	--	0.25	0.0
Arsenic	-- - --	2 / 2	6.00	32.0	CAA06-GW06-1013	19.0	18.4
Barium	-- - --	2 / 2	14.0	15.0	CAA06-GW01-1013	14.5	0.71
Beryllium	0.40 - 0.40	1 / 2	0.12	0.12	CAA06-GW01-1013	0.16	0.057
Cadmium	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Calcium	-- - --	2 / 2	21,000	36,000	CAA06-GW06-1013	28,500	10,607
Chromium	0.46 - 0.50	0 / 2	--	--	--	0.24	0.014
Cobalt	-- - --	2 / 2	0.55	8.70	CAA06-GW01-1013	4.63	5.76
Copper	0.50 - 2.40	0 / 2	--	--	--	0.73	0.67
Iron	-- - --	2 / 2	16,000	30,000	CAA06-GW06-1013	23,000	9,899
Lead	0.50 - 0.50	0 / 2	--	--	--	0.25	0.0
Magnesium	-- - --	2 / 2	2,700	3,400	CAA06-GW01-1013	3,050	495
Manganese	-- - --	2 / 2	330	700	CAA06-GW01-1013	515	262
Mercury	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Nickel	-- - --	2 / 2	0.29	1.20	CAA06-GW01-1013	0.75	0.64

**Table J-29**

**Summary Statistics - AOC 6 TNT Subarea Groundwater - Upgradient Wells**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

<b>Chemical</b>	<b>Range of Non-Detect Values</b>	<b>Frequency of Detection</b>	<b>Minimum Concentration Detected</b>	<b>Maximum Concentration Detected</b>	<b>Sample ID of Maximum Detected Concentration</b>	<b>Arithmetic Mean</b>	<b>Standard Deviation of Mean</b>
Potassium	-- - --	2 / 2	1,500	2,500	CAA06-GW06-1013	2,000	707
Selenium	0.91 - 1.00	0 / 2	--	--	--	0.48	0.032
Silver	0.10 - 0.10	0 / 2	--	--	--	0.050	0.0
Sodium	-- - --	2 / 2	8,200	9,300	CAA06-GW06-1013	8,750	778
Thallium	0.051 - 0.10	0 / 2	--	--	--	0.038	0.017
Vanadium	0.20 - 0.20	1 / 2	0.14	0.14	CAA06-GW01-1013	0.12	0.028
Zinc	5.30 - 5.30	1 / 2	16.0	16.0	CAA06-GW01-1013	9.33	9.44

Table J-30

## Reporting Limit to ESV Comparison

## Remedial Investigation Report

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Units	Frequency of Detection	Minimum Reporting Limit	Maximum Reporting Limit	Mean Concentration	ESV	Minimum Ratio	Maximum Ratio	Mean Ratio
<b>Surface Soil</b>									
4,6-Dinitro-2-methylphenol	UG/KG	0 / 7	940	1,200	506	1,000	0.94	1.20	0.51
4-Nitrophenol	UG/KG	0 / 4	940	1,000	481	380	2.47	2.63	1.27
Atrazine	UG/KG	0 / 7	370	460	201	11.9	31.1	38.7	16.9
<b>Subsurface Soil</b>									
4,6-Dinitro-2-methylphenol	UG/KG	0 / 7	910	1,100	484	1,000	0.91	1.10	0.48
4-Nitrophenol	UG/KG	0 / 4	910	1,100	491	380	2.39	2.89	1.29
Atrazine	UG/KG	0 / 7	360	450	193	11.9	30.3	37.8	16.2

Shaded cells indicate ratio  $\geq 1$

**Table J-31**

**Summary of Final Ecological Chemicals of Potential Concern**

**Remedial Investigation Report**

*Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia*

Chemical	Terrestrial Food Web	Surface Soil	Subsurface Soil	Groundwater
<b>Inorganics</b>				
Lead	x	K	K	
<b>Explosives</b>				
1,3,5-Trinitrobenzene		x	x	
1,3-Dinitrobenzene		x	x	
2,4,6-Trinitrotoluene		K	K	
2-Nitrotoluene		x		
3,5-Dinitroaniline		x	x	
4-Nitrotoluene			x	

Known to be, or likely to be, site-related

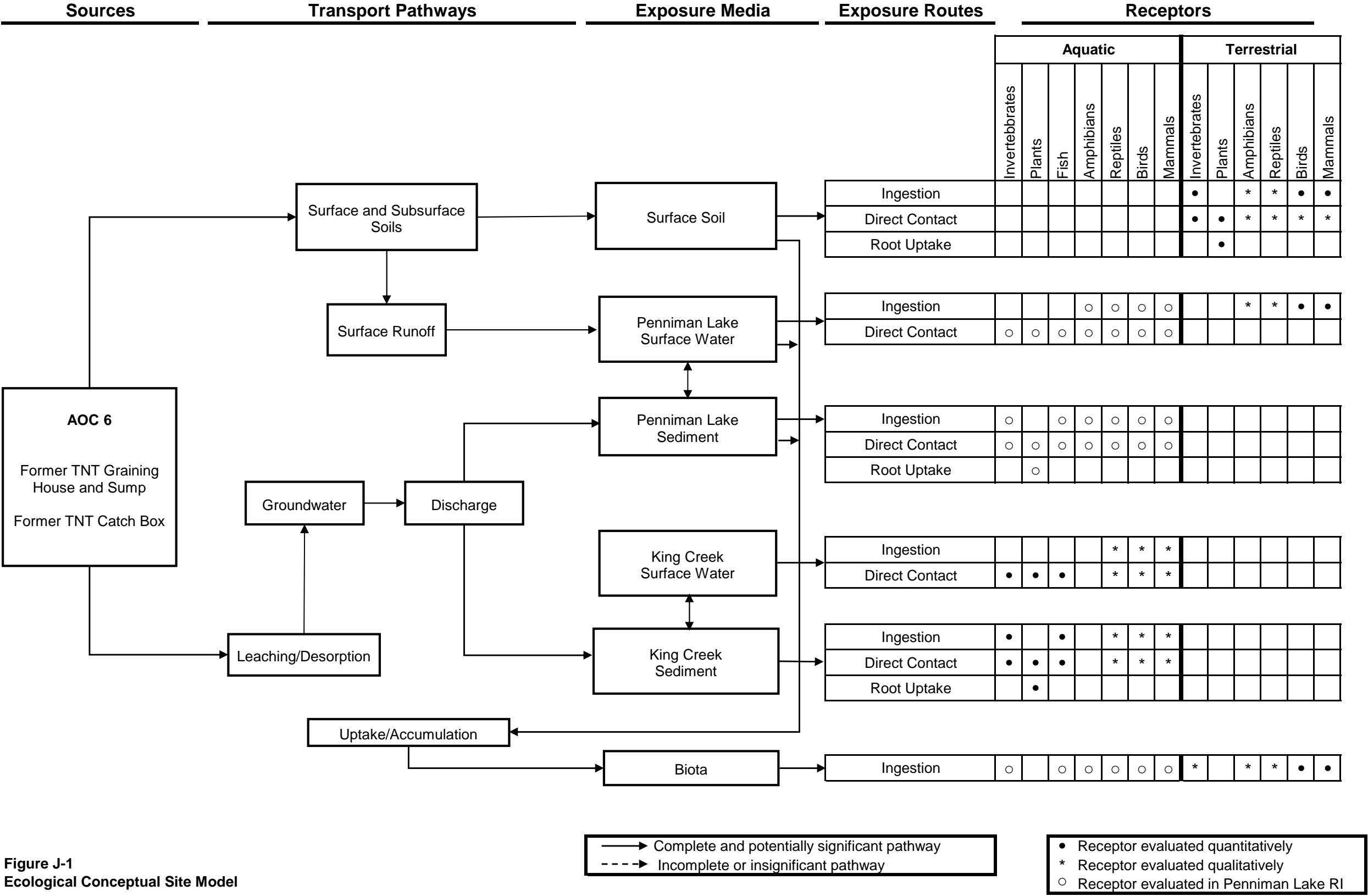
Not likely site-related

K - Key COPC (primary risk driver)

x - Minor COPC (not primary risk driver)

**Figure**

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## **Attachments**

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ATTACHMENT TABLE J-1-1  
Summary of Meadow Vole Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	6.04E-01	2.40	5.37	12.0	2.52E-01	1.13E-01	5.03E-02
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	4.53E+00	4.70	6.47	8.90	9.64E-01	7.00E-01	5.09E-01
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	1.80E-02	0.032	0.072	0.16	5.61E-01	2.51E-01	1.12E-01
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	1.31E-01	0.20	0.26	0.33	6.57E-01	5.11E-01	3.98E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	9.80E+00	75.4	169	377	1.30E-01	5.81E-02	2.60E-02
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	2.68E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	2.78E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	6.55E-03	0.62	1.37	3.07	1.07E-02	4.77E-03	2.13E-03
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	1.04E-02	0.62	1.37	3.07	1.69E-02	7.56E-03	3.38E-03
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	2.30E-02	0.62	1.37	3.07	3.75E-02	1.68E-02	7.51E-03
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	1.75E-02	0.62	1.37	3.07	2.84E-02	1.27E-02	5.69E-03
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	1.04E-02	0.62	1.37	3.07	1.69E-02	7.55E-03	3.38E-03
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	7.08E-03	0.62	1.37	3.07	1.15E-02	5.15E-03	2.31E-03
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	1.41E-02	0.62	1.37	3.07	2.30E-02	1.03E-02	4.60E-03
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	1.56E-02	2.00	2.83	4.00	7.82E-03	5.53E-03	3.91E-03
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	3.08E-02	2.00	6.32	20.0	1.54E-02	4.87E-03	1.54E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	2.05E-02	75.0	168	375	2.73E-04	1.22E-04	5.46E-05
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	5.87E-02	100	224	500	5.87E-04	2.62E-04	1.17E-04
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	1.11E-02	0.62	1.37	3.07	1.81E-02	8.11E-03	3.63E-03
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	1.44E-01	0.62	1.37	3.07	2.34E-01	1.05E-01	4.68E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- FIR = 0.0031
- FCxi = Chemical-specific
- PDFi = 0.020
- FCxi = Chemical-specific
- PDFi = 0.956
- SCx = Chemical-specific
- PDS = 0.024
- WIR = 0.0133
- WC = Chemical-specific
- BW = 0.0300
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- = Food ingestion rate (kg/day dry weight)
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- = Proportion of diet composed of food item (soil invertebrates)
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- = Proportion of diet composed of food item (terrestrial plants)
- = Concentration of chemical in soil (mg/kg, dry weight)
- = Proportion of diet composed of soil
- = Water ingestion rate (L/day)
- = Concentration of chemical in water (mg/L)
- = Body weight (kg)

ATTACHMENT TABLE J-1-2  
Summary of Short-Tailed Shrew Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	1.35E+01	2.40	5.37	12.0	5.61E+00	2.51E+00	1.12E+00
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	4.71E+01	4.70	6.47	8.90	1.00E+01	7.28E+00	5.29E+00
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	3.16E-01	0.032	0.072	0.16	9.88E+00	4.42E+00	1.98E+00
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	2.36E-01	0.20	0.26	0.33	1.18E+00	9.20E-01	7.17E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	5.82E+01	75.4	169	377	7.72E-01	3.45E-01	1.54E-01
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	5.49E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	5.50E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	9.18E-03	0.62	1.37	3.07	1.49E-02	6.68E-03	2.99E-03
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	2.54E-02	0.62	1.37	3.07	4.13E-02	1.85E-02	8.27E-03
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	2.06E-02	0.62	1.37	3.07	3.36E-02	1.50E-02	6.72E-03
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	1.77E-02	0.62	1.37	3.07	2.87E-02	1.29E-02	5.76E-03
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	1.98E-02	0.62	1.37	3.07	3.22E-02	1.44E-02	6.44E-03
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	1.42E-02	0.62	1.37	3.07	2.31E-02	1.03E-02	4.62E-03
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	3.21E-02	0.62	1.37	3.07	5.22E-02	2.34E-02	1.05E-02
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	8.39E-02	2.00	2.83	4.00	4.20E-02	2.97E-02	2.10E-02
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	5.52E-02	2.00	6.32	20.0	2.76E-02	8.73E-03	2.76E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	5.45E-02	75.0	168	375	7.27E-04	3.25E-04	1.45E-04
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	5.71E-02	100	224	500	5.71E-04	2.55E-04	1.14E-04
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	2.85E-02	0.62	1.37	3.07	4.63E-02	2.07E-02	9.27E-03
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	4.99E-02	0.62	1.37	3.07	8.12E-02	3.63E-02	1.63E-02

$$DI_x = \frac{[(\sum_i (FIR_i)(FC_{xi})(PDF_i))] + [(FIR_x)(SC_x)(PDS_x)] + [(WIR_x)(WC_x)]}{BW}$$

- DI = Chemical-specific

FIR = 0.0019

FCxi = Chemical-specific

PDFi = 0.823

FCxi = Chemical-specific

PDFi = 0.047

SCx = Chemical-specific

PDS = 0.130

WIR = 0.0048

WC = Chemical-specific

BW = 0.0133
- = Dietary intake for chemical (mg chemical/kg body weight/day)

= Food ingestion rate (kg/day dry weight)

= Concentration of chemical in food item (soil invertebrates, dry weight basis)

= Proportion of diet composed of food item (soil invertebrates)

= Concentration of chemical in food item (terrestrial plants, dry weight basis)

= Proportion of diet composed of food item (terrestrial plants)

= Concentration of chemical in soil (mg/kg, dry weight)

= Proportion of diet composed of soil

= Water ingestion rate (L/day)

= Concentration of chemical in water (mg/L)

= Body weight (kg)

ATTACHMENT TABLE J-1-3  
Summary of White-Footed Mouse Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	2.80E+00	2.40	5.37	12.0	1.17E+00	5.21E-01	2.33E-01
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	7.09E+00	4.70	6.47	8.90	1.51E+00	1.10E+00	7.97E-01
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	6.89E-02	0.032	0.072	0.16	2.15E+00	9.63E-01	4.31E-01
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	9.13E-02	0.20	0.26	0.33	4.56E-01	3.55E-01	2.77E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	1.38E+01	75.4	169	377	1.83E-01	8.19E-02	3.66E-02
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	2.14E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	2.17E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	7.80E-03	0.62	1.37	3.07	1.27E-02	5.68E-03	2.54E-03
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	1.12E-02	0.62	1.37	3.07	1.82E-02	8.17E-03	3.65E-03
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	1.35E-02	0.62	1.37	3.07	2.19E-02	9.80E-03	4.39E-03
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	1.14E-02	0.62	1.37	3.07	1.86E-02	8.33E-03	3.73E-03
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	1.01E-02	0.62	1.37	3.07	1.64E-02	7.33E-03	3.28E-03
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	8.83E-03	0.62	1.37	3.07	1.44E-02	6.42E-03	2.88E-03
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	1.35E-02	0.62	1.37	3.07	2.20E-02	9.86E-03	4.41E-03
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	2.45E-02	2.00	2.83	4.00	1.23E-02	8.68E-03	6.13E-03
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	2.25E-02	2.00	6.32	20.0	1.13E-02	3.56E-03	1.13E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	1.97E-02	75.0	168	375	2.63E-04	1.18E-04	5.27E-05
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	3.00E-02	100	224	500	3.00E-04	1.34E-04	6.00E-05
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	1.20E-02	0.62	1.37	3.07	1.96E-02	8.76E-03	3.92E-03
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	4.95E-02	0.62	1.37	3.07	8.04E-02	3.60E-02	1.61E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.00073
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.470
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.510
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.020
- = Proportion of diet composed of soil
- WIR = 0.0092
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.0141
- = Body weight (kg)

ATTACHMENT TABLE J-1-4

Summary of Red Fox Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil-Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil-Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	Regresson	3.02E+00	Regresson	3.14E+00	Regresson	3.14E+00	1.00E-02	3.27E-01	2.40	5.37	12.0	1.36E-01	6.09E-02	2.72E-02
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	Regression	2.39E+01	Regression	2.04E+01	Regression	4.90E+01	1.00E-02	3.19E+00	4.70	6.47	8.90	6.79E-01	4.93E-01	3.58E-01
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	0.130	1.69E-02	0.192	2.50E-02	0.192	2.50E-02	2.00E-04	5.10E-03	0.15	0.19	0.25	3.40E-02	2.64E-02	2.04E-02
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	Regression	8.57E-01	Regression	8.57E-01	Regression	8.57E-01	3.50E-02	4.76E-02	0.20	0.26	0.33	2.38E-01	1.85E-01	1.44E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	Regression	1.28E+02	Regression	1.13E+02	Regression	1.39E+02	3.40E-03	6.24E+00	75.4	169	377	8.28E-02	3.70E-02	1.66E-02
Semivolatile Organics																			
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	See footnote	2.88E-01	See footnote	2.16E-01	See footnote	3.62E-01	1.00E-02	1.47E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	See footnote	2.93E-01	See footnote	2.26E-01	See footnote	3.63E-01	1.00E-02	1.50E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regresson	1.80E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	1.54E-03	0.62	1.37	3.07	2.50E-03	1.12E-03	5.01E-04
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regresson	4.83E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.10E-03	0.62	1.37	3.07	3.42E-03	1.53E-03	6.85E-04
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.46E-03	0.62	1.37	3.07	4.00E-03	1.79E-03	8.02E-04
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regresson	1.22E-01	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.25E-03	0.62	1.37	3.07	3.66E-03	1.64E-03	7.33E-04
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regresson	4.92E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.04E-03	0.62	1.37	3.07	3.32E-03	1.49E-03	6.65E-04
Chrysene	1.50E-01	0.440	6.60E-02	Regresson	2.16E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	1.65E-03	0.62	1.37	3.07	2.68E-03	1.20E-03	5.38E-04
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.29E-03	0.62	1.37	3.07	3.73E-03	1.67E-03	7.47E-04
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	See footnote	3.48E-01	See footnote	1.08E-01	See footnote	5.67E-01	1.00E-02	1.66E-02	2.00	2.83	4.00	8.32E-03	5.88E-03	4.16E-03
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	See footnote	3.09E-01	See footnote	2.55E-01	See footnote	3.64E-01	1.00E-02	1.57E-02	2.00	6.32	20.0	7.84E-03	2.48E-03	7.84E-04
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	See footnote	2.55E-01	See footnote	1.55E-01	See footnote	3.59E-01	1.00E-02	1.32E-02	75.0	168	375	1.76E-04	7.88E-05	3.52E-05
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	See footnote	4.53E-01	See footnote	5.25E-01	See footnote	3.78E-01	1.00E-02	2.24E-02	100	224	500	2.24E-04	1.00E-04	4.48E-05
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	2.16E-03	0.62	1.37	3.07	3.51E-03	1.57E-03	7.03E-04
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	6.89E-03	0.62	1.37	3.07	1.12E-02	5.01E-03	2.24E-03

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)] ]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.1476 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.028 = Proportion of diet composed of soil
- WIR = 0.4115 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 3.17 = Body weight (kg)

ATTACHMENT TABLE J-1-5  
Summary of American Robin Exposure Doses (Omnivore) - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	5.89E+00	2.66	5.95	13.3	2.22E+00	9.91E-01	4.43E-01
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	1.82E+01	3.85	8.61	19.3	4.73E+00	2.12E+00	9.47E-01
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	1.43E-01	0.49	0.77	1.20	2.92E-01	1.87E-01	1.19E-01
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	1.61E-01	0.44	0.81	1.50	3.66E-01	1.98E-01	1.07E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	2.96E+01	66.1	148	331	4.47E-01	2.00E-01	8.95E-02
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	3.52E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	3.58E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	5.19E-03	7.10	15.9	35.5	7.31E-04	3.27E-04	1.46E-04
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	1.32E-02	7.10	15.9	35.5	1.87E-03	8.34E-04	3.73E-04
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	1.86E-02	7.10	15.9	35.5	2.62E-03	1.17E-03	5.24E-04
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	1.41E-02	7.10	15.9	35.5	1.99E-03	8.89E-04	3.97E-04
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	1.09E-02	7.10	15.9	35.5	1.53E-03	6.85E-04	3.06E-04
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	7.45E-03	7.10	15.9	35.5	1.05E-03	4.69E-04	2.10E-04
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	1.83E-02	7.10	15.9	35.5	2.57E-03	1.15E-03	5.14E-04
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	4.10E-02	0.113	0.253	0.565	3.63E-01	1.62E-01	7.26E-02
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	3.77E-02	3.39	7.58	17.0	1.11E-02	4.97E-03	2.22E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	3.14E-02	NA	NA	NA	NA	NA	NA
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	5.47E-02	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	1.50E-02	7.10	15.9	35.5	2.11E-03	9.44E-04	4.22E-04
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	1.00E-01	7.10	15.9	35.5	1.41E-02	6.32E-03	2.82E-03

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0074
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.435
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.519
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.046
- = Proportion of diet composed of soil
- WIR = 0.0129
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.0635
- = Body weight (kg)

ATTACHMENT TABLE J-1-6  
Summary of American Robin Exposure Doses (Invertivore) - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	8.55E+00	2.66	5.95	13.3	3.21E+00	1.44E+00	6.43E-01
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	2.16E+01	3.85	8.61	19.3	5.62E+00	2.51E+00	1.12E+00
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	2.06E-01	0.49	0.77	1.20	4.21E-01	2.69E-01	1.72E-01
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	1.33E-01	0.44	0.81	1.50	3.02E-01	1.64E-01	8.86E-02
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	3.64E+01	66.1	148	331	5.51E-01	2.47E-01	1.10E-01
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	3.18E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	3.18E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	4.71E-03	7.10	15.9	35.5	6.64E-04	2.97E-04	1.33E-04
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	1.31E-02	7.10	15.9	35.5	1.84E-03	8.22E-04	3.68E-04
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	9.36E-03	7.10	15.9	35.5	1.32E-03	5.90E-04	2.64E-04
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	7.66E-03	7.10	15.9	35.5	1.08E-03	4.82E-04	2.16E-04
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	9.36E-03	7.10	15.9	35.5	1.32E-03	5.90E-04	2.64E-04
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	7.65E-03	7.10	15.9	35.5	1.08E-03	4.82E-04	2.15E-04
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	1.73E-02	7.10	15.9	35.5	2.44E-03	1.09E-03	4.88E-04
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	5.14E-02	0.113	0.253	0.565	4.55E-01	2.03E-01	9.10E-02
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	3.18E-02	3.39	7.58	17.0	9.38E-03	4.19E-03	1.88E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	3.18E-02	NA	NA	NA	NA	NA	NA
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	3.18E-02	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	1.50E-02	7.10	15.9	35.5	2.12E-03	9.47E-04	4.24E-04
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	2.15E-02	7.10	15.9	35.5	3.03E-03	1.36E-03	6.07E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific

FIR = 0.0051

FCxi = Chemical-specific

PDFi = 0.954

FCxi = Chemical-specific

PDFi = 0.000

SCx = Chemical-specific

PDS = 0.046

WIR = 0.0129

WC = Chemical-specific

BW = 0.0635
- = Dietary intake for chemical (mg chemical/kg body weight/day)

= Food ingestion rate (kg/day dry weight)

= Concentration of chemical in food item (soil invertebrates, dry weight basis)

= Proportion of diet composed of food item (soil invertebrates)

= Concentration of chemical in food item (terrestrial plants, dry weight basis)

= Proportion of diet composed of food item (terrestrial plants)

= Concentration of chemical in soil (mg/kg, dry weight)

= Proportion of diet composed of soil

= Water ingestion rate (L/day)

= Concentration of chemical in water (mg/L)

= Body weight (kg)

ATTACHMENT TABLE J-1-7  
Summary of Mourning Dove Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	1.00E-02	8.98E-01	2.66	5.95	13.3	3.37E-01	1.51E-01	6.75E-02
Lead	1.10E+03	Regression	2.29E+02	Regression	1.35E+01	1.00E-02	1.35E+01	1.63	2.31	3.26	8.28E+00	5.86E+00	4.14E+00
Mercury	1.30E-01	20.63	2.68E+00	Regression	1.22E-01	2.00E-04	2.43E-02	0.45	0.64	0.90	5.41E-02	3.83E-02	2.71E-02
Selenium	2.00E+00	Regression	1.54E+00	Regression	1.09E+00	3.50E-02	2.32E-01	0.29	0.41	0.58	8.00E-01	5.66E-01	4.01E-01
Zinc	1.76E+02	Regression	4.66E+02	Regression	8.52E+01	3.40E-03	1.79E+01	66.1	148	331	2.70E-01	1.21E-01	5.40E-02
Semivolatile Organics													
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	1.00E-02	4.49E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	1.00E-02	4.68E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regression	1.80E-02	1.00E-02	6.16E-03	7.10	15.9	35.5	8.67E-04	3.88E-04	1.73E-04
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regression	4.83E-02	1.00E-02	1.45E-02	7.10	15.9	35.5	2.04E-03	9.12E-04	4.08E-04
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	1.00E-02	3.89E-02	7.10	15.9	35.5	5.48E-03	2.45E-03	1.10E-03
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regression	1.22E-01	1.00E-02	2.83E-02	7.10	15.9	35.5	3.99E-03	1.78E-03	7.98E-04
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regression	4.92E-02	1.00E-02	1.46E-02	7.10	15.9	35.5	2.06E-03	9.23E-04	4.13E-04
Chrysene	1.50E-01	0.440	6.60E-02	Regression	2.16E-02	1.00E-02	7.24E-03	7.10	15.9	35.5	1.02E-03	4.56E-04	2.04E-04
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	1.00E-02	2.14E-02	7.10	15.9	35.5	3.02E-03	1.35E-03	6.04E-04
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	1.00E-02	2.26E-02	0.113	0.253	0.565	2.00E-01	8.94E-02	4.00E-02
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	1.00E-02	5.26E-02	3.39	7.58	17.0	1.55E-02	6.94E-03	3.10E-03
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	1.00E-02	3.28E-02	NA	NA	NA	NA	NA	NA
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	1.00E-02	1.06E-01	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	1.00E-02	1.58E-02	7.10	15.9	35.5	2.23E-03	9.98E-04	4.46E-04
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	1.00E-02	2.71E-01	7.10	15.9	35.5	3.81E-02	1.70E-02	7.62E-03

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0209
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.950
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.050
- = Proportion of diet composed of soil
- WIR = 0.0175
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.1050
- = Body weight (kg)

ATTACHMENT TABLE J-1-8  
Summary of Red-tailed Hawk Exposure Doses - Screening (Step 2) - Maximum  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil-Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil-Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	3.47E+01	3.162	1.10E+02	0.084	2.91E+00	Regresson	3.02E+00	Regresson	3.14E+00	Regresson	3.14E+00	1.00E-02	1.30E-01	2.66	5.95	13.3	4.89E-02	2.19E-02	9.79E-03
Lead	1.10E+03	Regression	2.29E+02	Regresson	1.35E+01	Regresson	2.39E+01	Regresson	2.04E+01	Regresson	4.90E+01	1.00E-02	1.43E+00	3.85	8.61	19.3	3.72E-01	1.67E-01	7.45E-02
Mercury	1.30E-01	20.63	2.68E+00	Regresson	1.22E-01	0.130	1.69E-02	0.192	2.50E-02	0.192	2.50E-02	2.00E-04	1.04E-03	0.49	0.77	1.20	2.13E-03	1.36E-03	8.71E-04
Selenium	2.00E+00	Regression	1.54E+00	Regresson	1.09E+00	Regresson	8.57E-01	Regresson	8.57E-01	Regresson	8.57E-01	3.50E-02	3.79E-02	0.44	0.81	1.50	8.60E-02	4.66E-02	2.52E-02
Zinc	1.76E+02	Regression	4.66E+02	Regresson	8.52E+01	Regresson	1.28E+02	Regresson	1.13E+02	Regresson	1.39E+02	3.40E-03	5.20E+00	66.1	148	331	7.87E-02	3.52E-02	1.57E-02
Semivolatile Organics																			
4-Bromophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.566	2.09E-01	See footnote	2.88E-01	See footnote	2.16E-01	See footnote	3.62E-01	1.00E-02	1.27E-02	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	3.70E-01	1.000	3.70E-01	0.593	2.19E-01	See footnote	2.93E-01	See footnote	2.26E-01	See footnote	3.63E-01	1.00E-02	1.29E-02	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	1.10E-01	0.270	2.97E-02	Regresson	1.80E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Benzo(a)pyrene	3.70E-01	0.340	1.26E-01	Regresson	4.83E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Benzo(b)fluoranthene	3.70E-01	0.210	7.77E-02	0.480	1.78E-01	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Benzo(g,h,i)perylene	3.70E-01	0.150	5.55E-02	Regresson	1.22E-01	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Benzo(k)fluoranthene	3.70E-01	0.210	7.77E-02	Regresson	4.92E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Chrysene	1.50E-01	0.440	6.60E-02	Regresson	2.16E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Dibenz(a,h)anthracene	3.70E-01	0.490	1.81E-01	0.230	8.51E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Hexachlorobenzene	3.70E-01	1.690	6.25E-01	0.246	9.11E-02	See footnote	3.48E-01	See footnote	1.08E-01	See footnote	5.67E-01	1.00E-02	1.47E-02	0.113	0.253	0.565	1.30E-01	5.80E-02	2.59E-02
Hexachlorobutadiene	3.70E-01	1.000	3.70E-01	0.675	2.50E-01	See footnote	3.09E-01	See footnote	2.55E-01	See footnote	3.64E-01	1.00E-02	1.35E-02	3.39	7.58	17.0	3.98E-03	1.78E-03	7.97E-04
Hexachlorocyclopentadiene	3.70E-01	1.000	3.70E-01	0.393	1.45E-01	See footnote	2.55E-01	See footnote	1.55E-01	See footnote	3.59E-01	1.00E-02	1.13E-02	NA	NA	NA	NA	NA	NA
Hexachloroethane	3.70E-01	1.000	3.70E-01	1.439	5.33E-01	See footnote	4.53E-01	See footnote	5.25E-01	See footnote	3.78E-01	1.00E-02	1.94E-02	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	3.70E-01	0.410	1.52E-01	0.150	5.55E-02	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05
Pyrene	5.80E-01	0.390	2.26E-01	2.400	1.39E+00	0.000	0.00E+00	0.000	0.00E+00	0.000	0.00E+00	1.00E-02	7.10E-04	7.10	15.9	35.5	1.00E-04	4.47E-05	2.00E-05

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0395 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.000 = Proportion of diet composed of soil
- WIR = 0.0680 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.957 = Body weight (kg)

ATTACHMENT TABLE J-1-9  
Summary of Meadow Vole Exposure Doses - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	4.84E-02	2.40	5.37	12.0	2.02E-02	9.01E-03	4.03E-03
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	8.86E-01	4.70	6.47	8.90	1.89E-01	1.37E-01	9.96E-02
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	4.55E-03	0.032	0.072	0.16	1.42E-01	6.35E-02	2.84E-02
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	2.07E-02	0.20	0.26	0.33	1.03E-01	8.05E-02	6.27E-02

$$DI_x = \frac{[(\sum_i (FIR_i)(FC_{xi})(PDF_i))] + [(FIR_x)(SC_x)(PDS)] + [(WIR)(WC_x)]}{BW}$$

- DI = Chemical-specific
- FIR = 0.0021
- FCxi = Chemical-specific
- PDFi = 0.020
- FCxi = Chemical-specific
- PDFi = 0.956
- SCx = Chemical-specific
- PDS = 0.024
- WIR = 0.0090
- WC = Chemical-specific
- BW = 0.0428
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- = Food ingestion rate (kg/day dry weight)
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- = Proportion of diet composed of food item (soil invertebrates)
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- = Proportion of diet composed of food item (terrestrial plants)
- = Concentration of chemical in soil (mg/kg, dry weight)
- = Proportion of diet composed of soil
- = Water ingestion rate (L/day)
- = Concentration of chemical in water (mg/L)
- = Body weight (kg)

ATTACHMENT TABLE J-1-10

## Summary of Short-Tailed Shrew Exposure Doses - Baseline (Step 3A) - 95% UCL

## Remedial Investigation Report - AOC 6 TNT Subarea

## Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
<b>Metals</b>													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	4.79E-01	2.40	5.37	12.0	2.00E-01	8.92E-02	3.99E-02
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	1.14E+01	4.70	6.47	8.90	2.44E+00	1.77E+00	1.29E+00
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	8.13E-03	0.032	0.072	0.16	2.54E-01	1.14E-01	5.08E-02
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	5.85E-02	0.20	0.26	0.33	2.92E-01	2.28E-01	1.77E-01

$$DI_x = \frac{[(\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)  
 FIR = 0.0015 = Food ingestion rate (kg/day dry weight)  
 FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)  
 PDFi = 0.823 = Proportion of diet composed of food item (soil invertebrates)  
 FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)  
 PDFi = 0.047 = Proportion of diet composed of food item (terrestrial plants)  
 SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)  
 PDS = 0.130 = Proportion of diet composed of soil  
 WIR = 0.0038 = Water ingestion rate (L/day)  
 WC = Chemical-specific = Concentration of chemical in water (mg/L)  
 BW = 0.0169 = Body weight (kg)

ATTACHMENT TABLE J-1-11  
Summary of White-Footed Mouse Exposure Doses - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	6.55E-02	2.40	5.37	12.0	2.73E-02	1.22E-02	5.46E-03
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	1.37E+00	4.70	6.47	8.90	2.91E-01	2.11E-01	1.54E-01
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	2.28E-03	0.032	0.072	0.16	7.13E-02	3.19E-02	1.43E-02
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	2.06E-02	0.20	0.26	0.33	1.03E-01	8.04E-02	6.26E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.00050 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.470 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.510 = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.020 = Proportion of diet composed of soil
- WIR = 0.0062 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.0208 = Body weight (kg)

ATTACHMENT TABLE J-1-12

Summary of Red Fox Exposure Doses - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil- Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil- Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	Regresson	1.52E+00	Regresson	1.58E+00	Regresson	1.58E+00	1.00E-02	5.91E-02	2.40	5.37	12.0	2.46E-02	1.10E-02	4.93E-03
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	Regression	1.49E+01	Regression	1.18E+01	Regression	2.92E+01	1.00E-02	9.62E-01	4.70	6.47	8.90	2.05E-01	1.49E-01	1.08E-01
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	0.130	1.02E-02	0.067	5.28E-03	0.067	5.28E-03	2.00E-04	4.99E-04	0.15	0.19	0.25	3.33E-03	2.58E-03	2.00E-03
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	Regression	5.25E-01	Regression	5.25E-01	Regression	5.25E-01	3.50E-02	1.84E-02	0.20	0.26	0.33	9.22E-02	7.18E-02	5.59E-02

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.1231 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.028 = Proportion of diet composed of soil
- WIR = 0.3494 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 4.06 = Body weight (kg)

ATTACHMENT TABLE J-1-13  
Summary of American Robin Exposure Doses (Omnivore) - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	2.02E-01	2.66	5.95	13.3	7.61E-02	3.40E-02	1.52E-02
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	4.53E+00	3.85	8.61	19.3	1.18E+00	5.26E-01	2.35E-01
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	6.62E-03	0.49	0.77	1.20	1.35E-02	8.63E-03	5.52E-03
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	3.47E-02	0.44	0.81	1.50	7.89E-02	4.27E-02	2.31E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0055
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.435
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.519
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.046
- = Proportion of diet composed of soil
- WIR = 0.0106
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.077
- = Body weight (kg)

ATTACHMENT TABLE J-1-14  
Summary of American Robin Exposure Doses (Invertivore) - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	2.39E-01	2.66	5.95	13.3	8.98E-02	4.01E-02	1.80E-02
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	5.45E+00	3.85	8.61	19.3	1.42E+00	6.33E-01	2.83E-01
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	4.62E-03	0.49	0.77	1.20	9.43E-03	6.02E-03	3.85E-03
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	3.42E-02	0.44	0.81	1.50	7.77E-02	4.21E-02	2.28E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0038
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.954
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.000
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.046
- = Proportion of diet composed of soil
- WIR = 0.0106
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.077
- = Body weight (kg)

ATTACHMENT TABLE J-1-15  
Summary of Mourning Dove Exposure Doses - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	1.00E-02	1.69E-01	2.66	5.95	13.3	6.37E-02	2.85E-02	1.27E-02
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	1.00E-02	3.61E+00	1.63	2.31	3.26	2.21E+00	1.57E+00	1.11E+00
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	2.00E-04	1.28E-02	0.45	0.64	0.90	2.84E-02	2.01E-02	1.42E-02
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	3.50E-02	4.21E-02	0.29	0.41	0.58	1.45E-01	1.03E-01	7.28E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0176 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.050 = Proportion of diet composed of soil
- WIR = 0.0148 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.1265 = Body weight (kg)

ATTACHMENT TABLE J-1-16  
Summary of Red-tailed Hawk Exposure Doses - Baseline (Step 3A) - 95% UCL  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	95% UCL Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil- Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil- Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	95% UCL Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	1.36E+01	0.320	4.36E+00	0.041	5.58E-01	Regresson	1.52E+00	Regresson	1.58E+00	Regresson	1.58E+00	1.00E-02	5.11E-02	2.66	5.95	13.3	1.92E-02	8.59E-03	3.84E-03
Lead	3.79E+02	Regression	9.69E+01	Regression	7.41E+00	Regresson	1.49E+01	Regression	1.18E+01	Regresson	2.92E+01	1.00E-02	6.55E-01	3.85	8.61	19.3	1.70E-01	7.61E-02	3.40E-02
Mercury	7.86E-02	1.186	9.33E-02	Regression	9.26E-02	0.130	1.02E-02	0.067	5.28E-03	0.067	5.28E-03	2.00E-04	1.80E-04	0.49	0.77	1.20	3.68E-04	2.35E-04	1.50E-04
Selenium	5.45E-01	Regression	5.95E-01	Regression	2.60E-01	Regresson	5.25E-01	Regression	5.25E-01	Regresson	5.25E-01	3.50E-02	1.88E-02	0.44	0.81	1.50	4.27E-02	2.31E-02	1.25E-02

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0360 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.000 = Proportion of diet composed of soil
- WIR = 0.0639 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 1.126 = Body weight (kg)

ATTACHMENT TABLE J-1-17  
Summary of Meadow Vole Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	3.85E-02	2.40	5.37	12.0	1.60E-02	7.17E-03	3.20E-03
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	3.66E-01	4.70	6.47	8.90	7.80E-02	5.67E-02	4.12E-02
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	4.10E-03	0.032	0.072	0.16	1.28E-01	5.73E-02	2.56E-02
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	1.75E-02	0.20	0.26	0.33	8.73E-02	6.79E-02	5.29E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0021 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.020 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.956 = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.024 = Proportion of diet composed of soil
- WIR = 0.0090 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.0428 = Body weight (kg)

ATTACHMENT TABLE J-1-18  
Summary of Short-Tailed Shrew Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	3.86E-01	2.40	5.37	12.0	1.61E-01	7.20E-02	3.22E-02
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	4.27E+00	4.70	6.47	8.90	9.08E-01	6.60E-01	4.80E-01
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	6.83E-03	0.032	0.072	0.16	2.13E-01	9.54E-02	4.27E-02
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	5.57E-02	0.20	0.26	0.33	2.79E-01	2.17E-01	1.69E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0015 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.823 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.047 = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.130 = Proportion of diet composed of soil
- WIR = 0.0038 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.0169 = Body weight (kg)

ATTACHMENT TABLE J-1-19  
Summary of White-Footed Mouse Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	5.21E-02	2.40	5.37	12.0	2.17E-02	9.70E-03	4.34E-03
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	5.48E-01	4.70	6.47	8.90	1.17E-01	8.47E-02	6.16E-02
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	1.97E-03	0.032	0.072	0.16	6.16E-02	2.76E-02	1.23E-02
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	1.57E-02	0.20	0.26	0.33	7.83E-02	6.09E-02	4.74E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.00050
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.470
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.510
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.020
- = Proportion of diet composed of soil
- WIR = 0.0062
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.0208
- = Body weight (kg)

ATTACHMENT TABLE J-1-20

Summary of Red Fox Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil- Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil- Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	Regression	1.30E+00	Regression	1.35E+00	Regression	1.35E+00	5.00E-03	4.95E-02	2.40	5.37	12.0	2.06E-02	9.22E-03	4.12E-03
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	Regression	9.05E+00	Regression	6.56E+00	Regression	1.68E+01	5.00E-03	4.56E-01	4.70	6.47	8.90	9.70E-02	7.05E-02	5.12E-02
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	0.130	8.57E-03	0.067	4.43E-03	0.067	4.43E-03	1.00E-04	4.27E-04	0.15	0.19	0.25	2.84E-03	2.20E-03	1.71E-03
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	Regression	5.31E-01	Regression	5.31E-01	Regression	5.31E-01	1.75E-02	1.71E-02	0.20	0.26	0.33	8.57E-02	6.67E-02	5.19E-02

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.1231 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.437 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.028 = Proportion of diet composed of soil
- WIR = 0.3494 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 4.06 = Body weight (kg)

ATTACHMENT TABLE J-1-21  
Summary of American Robin Exposure Doses (Omnivore) - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	1.63E-01	2.66	5.95	13.3	6.13E-02	2.74E-02	1.23E-02
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	1.76E+00	3.85	8.61	19.3	4.58E-01	2.05E-01	9.15E-02
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	5.78E-03	0.49	0.77	1.20	1.18E-02	7.54E-03	4.82E-03
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	3.31E-02	0.44	0.81	1.50	7.52E-02	4.07E-02	2.21E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0055
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.435
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.519
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.046
- = Proportion of diet composed of soil
- WIR = 0.0106
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.077
- = Body weight (kg)

ATTACHMENT TABLE J-1-22  
Summary of American Robin Exposure Doses (Invertivore) - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	1.93E-01	2.66	5.95	13.3	7.24E-02	3.24E-02	1.45E-02
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	2.13E+00	3.85	8.61	19.3	5.52E-01	2.47E-01	1.10E-01
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	3.86E-03	0.49	0.77	1.20	7.89E-03	5.04E-03	3.22E-03
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	3.24E-02	0.44	0.81	1.50	7.37E-02	3.99E-02	2.16E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific
- = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0038
- = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.954
- = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific
- = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.000
- = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific
- = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.046
- = Proportion of diet composed of soil
- WIR = 0.0106
- = Water ingestion rate (L/day)
- WC = Chemical-specific
- = Concentration of chemical in water (mg/L)
- BW = 0.077
- = Body weight (kg)

ATTACHMENT TABLE J-1-23  
Summary of Mourning Dove Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals													
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	5.00E-03	1.37E-01	2.66	5.95	13.3	5.13E-02	2.30E-02	1.03E-02
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	5.00E-03	1.37E+00	1.63	2.31	3.26	8.41E-01	5.95E-01	4.21E-01
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	1.00E-04	1.16E-02	0.45	0.64	0.90	2.57E-02	1.82E-02	1.29E-02
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	1.75E-02	4.14E-02	0.29	0.41	0.58	1.43E-01	1.01E-01	7.14E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0176 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.050 = Proportion of diet composed of soil
- WIR = 0.0148 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 0.1265 = Body weight (kg)

ATTACHMENT TABLE J-1-24

Summary of Red-tailed Hawk Exposure Doses - Baseline (Step 3A) - Mean  
Remedial Investigation Report - AOC 6 TNT Subarea  
Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Omnivore Soil-Mammal BAF	Omnivore Small Mammal Concentration (mg/kg dw)	Herbivore Soil-Mammal BAF	Herbivore Small Mammal Concentration (mg/kg dw)	Insectivore Soil-Mammal BAF	Insectivore Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	MATC HQ	LOAEL HQ
Metals																			
Chromium	1.10E+01	0.320	3.52E+00	0.041	4.51E-01	Regression	1.30E+00	Regression	1.35E+00	Regression	1.35E+00	5.00E-03	4.35E-02	2.66	5.95	13.3	1.64E-02	7.31E-03	3.27E-03
Lead	1.23E+02	Regression	3.90E+01	Regression	3.94E+00	Regression	9.05E+00	Regression	6.56E+00	Regression	1.68E+01	5.00E-03	3.75E-01	3.85	8.61	19.3	9.73E-02	4.35E-02	1.95E-02
Mercury	6.59E-02	1.186	7.82E-02	Regression	8.41E-02	0.130	8.57E-03	0.067	4.43E-03	0.067	4.43E-03	1.00E-04	1.47E-04	0.49	0.77	1.20	3.01E-04	1.92E-04	1.23E-04
Selenium	5.61E-01	Regression	6.08E-01	Regression	2.68E-01	Regression	5.31E-01	Regression	5.31E-01	Regression	5.31E-01	1.75E-02	1.80E-02	0.44	0.81	1.50	4.09E-02	2.21E-02	1.20E-02

It was assumed that the concentration of each chemical in the small mammal’s tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

- DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
- FIR = 0.0360 = Food ingestion rate (kg/day dry weight)
- FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
- FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants)
- FCxi = Chemical-specific = Concentration of chemical in food item (omnivorous small mammals, dry weight basis)
- PDFi = 0.000 = Proportion of diet composed of food item (omnivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (herbivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (herbivorous small mammals)
- FCxi = Chemical-specific = Concentration of chemical in food item (insectivorous small mammals, dry weight basis)
- PDFi = 0.500 = Proportion of diet composed of food item (insectivorous small mammals)
- SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
- PDS = 0.000 = Proportion of diet composed of soil
- WIR = 0.0639 = Water ingestion rate (L/day)
- WC = Chemical-specific = Concentration of chemical in water (mg/L)
- BW = 1.126 = Body weight (kg)

**Regulatory Acceptance**

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# COMMONWEALTH of VIRGINIA

## DEPARTMENT OF ENVIRONMENTAL QUALITY

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Molly Joseph Ward  
Secretary of Natural Resources

David K. Paylor  
Director

(804) 698-4000  
1-800-592-5482

January 14, 2015

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26  
Hampton Roads Restoration Product Line, Code OPHREV4  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Remedial Investigation Report  
AOC 6 TNT Subareas  
Naval Weapons Station Yorktown  
Cheatham Annex  
Williamsburg, Virginia

Dear Mr. Park:

The Virginia Department of Environmental Quality (DEQ) has received the *Draft Remedial Investigation Report* (RI Report) for AOC 6 TNT Subareas at Naval Weapons Station Yorktown, Cheatham Annex (CAX), Williamsburg, Virginia. The RI Report, prepared by CH2M HILL, was received by the DEQ on November 7, 2014.

Thank you for providing the DEQ's Office of Remediation Programs the opportunity to review the above-referenced RI Report. Subsequent to DEQ's internal review and discussion during the November 2014 CAX Partnering Meeting, this office concurs with the recommendation to prepare a Focused Feasibility Study (FFS) to address potentially unacceptable human health or ecological risks associated with TNT and lead in soil. The DEQ recommends submittal of the *Final Remedial Investigation Report*.

Please contact me at (804) 698-4125 or [wade.smith@deq.virginia.gov](mailto:wade.smith@deq.virginia.gov) with any additional questions.

Sincerely,

A handwritten signature in blue ink, appearing to read "Wade M. Smith".

Wade M. Smith  
Remediation Project Manager  
Office of Remediation Programs

cc: Jerry Hoover, EPA



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029

August 26, 2015

Mrs. Angela Jones  
Bldg. N-26 Room 3300  
NAVFAC MIDLANT  
9742 Maryland Ave.  
Norfolk, VA 23511

Subject: Draft Remedial Investigation (RI) Report for AOC 6 TNT Subareas, Naval Weapons  
Station Yorktown Cheatham Annex, Williamsburg, Virginia

Mrs. Jones:

EPA has reviewed the Navy's responses to EPA comments on the subject Draft RI Report submitted via email from Marlene Ivester of CH2M Hill dated 5/4/15, and the revisions to the subject Draft RI Report submitted via email from Marlene Ivester dated 7/30/15. EPA accepts the Navy's responses and the revisions to the Report, and has no further comments on this document. Please provide a final copy for our records. If you have any questions, please contact me at 215-814-2077.

Sincerely,

A handwritten signature in blue ink, which appears to read "Gerald F. Hoover", is positioned above the printed name.

Gerald F. Hoover, RPM  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029**

February 9, 2015

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26, Room 3208  
Attention: Code OPHE3, Mr. Scott Park  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Subject: Draft Remedial Investigation Report for AOC 6 TNT Subareas, Naval Weapons Station  
Yorktown Cheatham Annex, Williamsburg, Virginia, November 2014

Mr. Park:

Thank you for the opportunity to review the subject document. Attached are EPA's comments on the document. If you have any questions, please contact me at 215-814-2077.

Sincerely,

A handwritten signature in blue ink, reading "Gerald F. Hoover", is positioned above the typed name.

Gerald F. Hoover, RPM  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ

### **Hydro Comment:**

The concentrations of arsenic and iron in the up-gradient monitoring wells MW-06 and MW-02 are not a sufficient line of evidence to demonstrate that the arsenic and iron concentrations in groundwater at the site are attributable to background conditions. The Navy should explain in more detail, and should provide additional data, that can clearly demonstrate that the concentrations of arsenic and iron in groundwater are indeed attributable to naturally occurring background conditions.

### **BTAG Comments:**

1. Table 2-2 Groundwater and Penniman Lake Surface Water Elevations: According to this table the groundwater elevations ranged from 4.39 to 6.35 feet above mean sea level (amsl) and the Penniman Lake surface water elevation was 8.06 amsl. This report does not indicate how deep Penniman Lake is, therefore, it seems reasonable that there is a direct connection between groundwater and the lake and the lake could be gaining or losing depending on conditions. The connection between groundwater and Penniman Lake should be clarified.
2. Figure 2-1 AOC 6 TNT Subareas RI Sample Locations: This figure identifies a berm to the north of the TNT Graining House and Catch Box Ruins. The text should explain the purpose and origin of the berm and why no samples were collected from it. The original topography of the area appears to be about 16 feet and the current top of the berm is approximately 30 feet (Figure 3-1) [see also Appendix J Ecological Risk Assessment, Section J.2.1]. The berm appears to be approximately 60 feet by 100 feet.
3. Figure 2-1: Previous comments identified the need for additional samples (surface water, sediment, and porewater) in King Creek adjacent to this site (e.g., Section 3.5.4 of this document also supports this position) and in the drainage feature from the dam to the creek, including the creek.
4. Figure 2-1: No samples were collected from the graining house or the sump. Even if these were constructed of concrete, the integrity of the floor may have been compromised and allowed contaminants to escape to an area that has not been sampled. These contaminant concentrations may still be in the migration pathway. An explanation should be provided on why samples were not collected from these areas.
5. Section 6.3 on page 6-2 states that since Penniman Lake has now received a site designation (AOC 9), any further evaluation of surface water and sediment offshore of the AOC 6 TNT Subareas has been deferred to the Penniman Lake Site Inspection (SI). This approach would be acceptable if sediment sampling as part of the Penniman Lake SI was sufficient to characterize the nature and extent of explosives at AOC 6. However, sediment sampling in Penniman Lake adjacent to AOC 6 is limited (only one sample) and additional sampling as part of the Penniman Lake SI is recommended. Any additional sampling needs to consider the fact that activity at AOC 6 predates

construction of the dam which likely results in different migration pathways than those present today.

6. Page 6-4, Section 6.5.2 Aquatic Habitats: The potential for risk from contaminants to ecological receptors (e.g., groundwater to surface water) has existed at this site since World War I. This means the contaminants may have already reached Penniman Lake or King Creek and may be different than the contaminants found in the groundwater during this study. This supports the need to assess the historical groundwater contaminant migration pathway, potentially including the collection sediment samples for use in the ecological risk assessment.

#### Appendix J Ecological Risk Assessment

7. Page J-15, Section J.4.1 Medium-Specific ESVs: For both soil and surface water the text indicates that when more than one ESV (ecological screening value) was available, "...the lowest of these values was typically selected." Please identify which contaminants did not have the lowest ESV selected and state the reasons why this approach was used.
8. Page J-19, Section J.5.3.2 Terrestrial Food Web Exposures: The text states "...although chemicals that exceeded the MATC, but not the LOAEL, were discussed for possible risk management considerations." The results of this discussion including the possible risk management consideration need to be included in this section.
9. Page J-21, Section J.5.4 Aquatic Habitats: The use of mean site concentrations are not appropriate for determining risk to ecological receptors that are immobile or have a limited home range. Maximum concentrations must also be considered when assessing risk to lower trophic level receptors.
10. Page J-22, Section J.5.5.2 Aquatic Habitats: The text states "...groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota." Knowing when the dam was installed would help support or refute the first portion of this quote. Because no sampling has occurred in King Creek and only one sediment sample is located in Penniman Lake adjacent to this site, support for this position is not sufficient.
11. Page J-25, Section J.6 Uncertainties: Assessing ecological risk to lower trophic level receptors needs to consider maximum, not just mean, concentrations. The Wildlife Factors Handbook does not evaluate lower trophic level ecological receptors that are immobile or have a limited home range nor does it "specify" the use of average media concentrations. Citing this document to support using mean versus maximum concentrations for lower trophic level receptors is not appropriate.
12. Page J-26, Section J.7 Risk Summary and Conclusions: The text states "Based on the results of this evaluation, groundwater is not a significant transport medium for site-

related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.” Based on this report, groundwater may discharge to both of these surface water bodies. Depending on how long the dam has been operational compared with AOC 6 TNT being constructed, groundwater flow may have been different than today (e.g., more flow toward Penniman Lake [or the wetland that was present before the lake]). The text does indicate that groundwater tends to flow toward King Creek. This means that additional sediment samples may be warranted from King Creek adjacent to (in the groundwater discharge area), upstream, and downstream of this site. In addition, more sediment samples need to be collected in Penniman Lake near this site in the groundwater discharge area. These would be in addition to Penniman Lake sediment sample CAA06-SD01.

### **Tox Comments:**

Overall, the methodologies to complete the human health risk assessment appear appropriate; however, the following comments and recommendations must be considered as the draft RI is finalized.

#### *Major Concerns:*

1. Agree with the recommendations on page 8-2 in Section 8.2, except for the recommendation #3. For groundwater, the comparison to background should include a more robust statistical analysis than comparing the range of two background wells (one of which is debatable, see comment under Section 4 below) to the range of constituent concentrations at monitoring wells. The iron and arsenic concentrations in the monitoring wells may be attributable to naturally occurring background levels; however, the current analysis does not definitively support this conclusion. Recommend including groundwater as needing further action unless background analysis is improved.
2. Lead was not identified as a COPC in Section H.6.2. Risk Assessment Results. This determination is correct using the mean concentration in soil and subsurface soil and the exposure parameters described in the Table 4s; however, the highest concentration observed, 1,100 mg/kg, was from a subsurface soil sample from within the Catch Box Ruins and was identified as an outlier using ProUCL 5.0. The next highest concentration, 580 mg/kg, was from a surface soil sample also within the Catch Box Ruins. Section H.6.4 addresses the possibility of lead as a hot spot but fails to provide a strategy moving forward. Recommend calculating human health risk of exposure to lead in surface and subsurface soils using concentrations within Catch Box Ruins (using sample Stations CAA06-SO01 and SO26).

#### *Nature and Extent of Contamination (Section 4)*

- Page 4-1, 3<sup>rd</sup> paragraph – disagree with selection of MW-6 as a source of background concentrations for groundwater. This well, while outside the arbitrary TNT Subareas Study boundary, is more similar and closer in location to MW-2 than MW-1 (the other background source well).

#### *Human Health Risk Assessment (Section 5)*

- Page 5-3 – the COCs identified appear appropriate
- Page 5-3, last paragraph – replace “were found to” with “may,” such that the arsenic and iron concentrations in soil “may be” attributable to naturally occurring background conditions. For a more definitive conclusion, a statistical comparison of estimated background concentrations with observed site concentrations is needed.
- Page 5-3 – please add text discussing risks associated with exposures to chromium VI to Appendix H, Section H.8, HHR Summary.
- Page 5-4, first paragraph – delete comparison of iron ingestion for on-site receptor to recommended daily allowance and conclusion that iron ingestion from on-site ground water would be below the recommended daily allowance (RDA). This statement ignores that the iron intake from the ground water is not the sole source of iron and would be combined with regular dietary intake. The combined dietary intake, from ground water and diet, may be greater than the RDA; unfortunately, the text does not provide a quantitative comparison of the RDA with a combined iron intake, diet and on-site ground water, for any of the receptors.

#### *Chemical Fate and Transport (Section 7)*

- Page 7-5, top of page – The sentence that only 3 inorganic constituents were identified as COCs in surface soil is followed by a sentence that indicates that lead was one of the 3 inorganic COCs. Lead was also labeled as a COC on page 7-7, first bullet. However, lead is not included as a COC in Section 5 or identified as such in Appendix H. Please clarify that lead was a COC in the ecological RA. A table outlining the COCs in each assessment at the beginning of Section 7 would be helpful.
- Page 7-7, last bullet – Definitively attributing arsenic and iron concentrations in soil to naturally occurring background is not possible given the information available and lack of statistical analysis. Arsenic and iron may be attributed to background. Replace “are” with “may be.”

#### *Conclusions and Recommendations (Section 8)*

- Page 8-1, 1<sup>st</sup> paragraph – The comparison to background should include a more robust statistical analysis than comparing the range of two background wells (one of which is debatable) to the range of constituent concentrations at monitoring wells. The iron and arsenic concentrations in the monitoring wells may very well be attributable to naturally occurring background levels; however, the current analysis does not definitively support this conclusion. Recommend including groundwater as needing further action unless background analysis is improved.
- Page 8-2, Section 8.2 – Recommendations
  1. FFS for TNT and lead in soil → Agree.
    - No further action for arsenic and chromium VI in soil → Agree.
      - Provide reference to source of background analysis. A table may be beneficial comparing the 95% UTL for surface soil and for subsurface soil against the observed arsenic and chromium concentrations. This is the only place in document that this comparison is made and a transparent explanation is beneficial.

2. No further action for 2-nitrotoluene in soil → Agree.
3. No further action for arsenic and iron in groundwater → Disagree. Background comparison not sufficient to make this determination.

*Laboratory Analytical Data (Appendix G)*

- Table G-3 – Table heading incorrectly labels the data as Raw Surface Soil. The data in the table are for groundwater.

*Draft Human Health Risk Assessment (Appendix H)*

- Page H-4, Section H.3.2 – Selection of COPCs – Disagree with utilization of MW-6 as source of background groundwater concentrations. In addition, the comparison to background should rely on a more robust statistically significant analysis than comparing maximum constituent levels.
- Page H-5, Section H.4.1 – Conceptual Site Model for Human Health – Recommend including brief explanation, such as that included in Section 5.2, as to why the inhalation route is not a complete exposure pathway prior to bulleted list of current receptors and complete exposure routes.
- Page H-12, Section H.6.2.3 – Current Child Recreational User (as well as other relevant areas of document) – Recommend removing phrase “conservatively used to evaluate recreational exposure to soil,” as this statement fails to provide meaningful information to the bullets. More appropriate in uncertainty section or not included in document at all, due to inherent ‘conservatism’ in risk assessment.
- Section H.7:
  - Page H-15, Section H.7.1, 4<sup>th</sup> paragraph – Delete: “Therefore, it is possible that some of the risk associated with exposure to arsenic in soil is from background conditions.” This statement is misleading, as there were arsenic concentrations that exceeded the 95% UTL from the CAX/Yorktown background and contributed to the risk calculation.
  - Page H-16, Section H.7.2, 1<sup>st</sup> paragraph – Recommend: “... generally conservative and reflect ~~worst-case~~, or upper bound, assumptions for the exposure.” The exposure factors are upper bound assumptions and the ‘worst-case’ descriptor is undefined.
  - Page H-16, Section H.7.2, 3<sup>rd</sup> paragraph – Delete: “During many construction projects, clean fill material... after any construction activities.” The information provided by these 3 sentences is conjecture and does not present substantive information critical to the risk assessment.
  - Page H-16, Section H.6.3, 1<sup>st</sup> paragraph – Delete: “The noncarcinogenic toxicity factors are most likely an overestimate of actual toxicity.” Conjecture.
  - Page H-16, Section H.6.3, 2<sup>nd</sup> paragraph – Delete: “...however, most of the experimental studies indicate the existence of a threshold value.” Incorrect. A threshold for carcinogenicity cannot be determined by a single experimental study, and the statement that ‘most’ experimental studies support a threshold is not supported.
  - Page H-16, Section H.6.3, 2<sup>nd</sup> paragraph – Rewrite: “Uncertainty is also associated with the application of the ~~MMOA~~ AADAFs for chromium due to its mutagenic MOA; this may overestimate or underestimate risks.

- Page H-16 – H-17, Section H.6.3, 3<sup>rd</sup> paragraph – Delete. PPRTVs are supported by the Agency.
- Page H-16 – H-17, Section H.6.3, 4<sup>th</sup> paragraph – Delete. The ‘true’ cancer risk is unknown and cannot be predicted to be ‘less’ than the predicted value.
- Page H-16 – H-17, Section H.6.3, 5<sup>th</sup> paragraph – Delete. The interspecies uncertainty is captured in the interspecies uncertainty factor in the development of the RfD/RfC and is addressed in the toxicity assessment.
- Section H.78 – Human Health Risk Summary – The COCs identified appear appropriate.
- Section H.8 – Human Health Risk Summary – Delete text concluding that iron ingestion from on-site groundwater would be below the recommended daily allowance (RDA) (a reference for the RDA was not provided). This statement ignores that the iron intake from the groundwater is not the sole source of iron and would be combined with regular dietary intake. The combined dietary intake, from groundwater and diet, may be greater than the RDA; unfortunately, the text does not provide a comparison of the RDA with a combined iron intake, diet and on-site groundwater, for any of the receptors.

*Draft Human Health Risk Assessment Tables (Appendix I)*

- Reference EPA, 2014 → EPA, 2014c throughout Table 4s.
- Table 4.1.CTE (and elsewhere) – Recommend ingestion rate for child of 50 rather than convoluted time-weighted average for birth to <6 years.
- Table 4.2.RME (and elsewhere) – construction worker – Please justify/clarify exposure duration of 1 year for construction worker ingestion of surface and subsurface soil. Support for this parameter was not found in the reference provided.
- Table 4.2.RME – resident (child/adult) – The age-adjusted ingestion rate of soil is not generally used to calculate the lifetime cancer risk for a resident (child/adult). The cancer risk is calculated for the child and for the adult, individually, and the cancer risks are then summed. It is recommended that the parameters for the child/adult resident are removed.
- Table 4.2.RME – construction worker – the Exposure Factors Handbook recommends a soil to skin adherence factor of 0.3; compared to the 0.12 provided in the draft table. Please clarify or use 0.3 from EFH.
- Table 4.3.RME – adult base worker, tap water – ingestion rate of water – the footnote states that 1.25 is half the value from EPA, 1991, but the reference in the table is EPA, 2014. Please clarify or correct footnote.
- Table 4.3.CTE – adult base worker, tap water – ingestion rate of water – assumes half ingestion rate of adult resident from EF Handbook but the adult intake rate was updated to 2.5 from 2. Please clarify or use 1.25 L/day.
- Table 5.1 – insert footnote describing process for selecting RfDs for 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene, which do not have RfDs, based on 2,4-dinitrotoluene.
- Table 6.1 – Change column heading ‘EPA Carcinogen Group’ to ‘Carcinogenicity Classification’ – not all the carcinogenicity classifications are based on EPA documents.
- Table 6.1 – Is the source for the chromium VI carcinogenicity classification CalEPA? Could not locate NJDEP document on chromium VI.
- Table 7.6.CTE – The cancer risk for the ingestion route CTE in the future construction worker could not be verified. Agency calculated risks were:

	calculated by Agency	draft HHRA
2,4-dinitrotoluene	3.4E-08	3.7E-09
2,4,6-trinitrotoluene	4.3E-06	4.70E-07
2-nitrotoluene	5.8E-07	6.50E-08
arsenic	4.9E-07	5.40E-08
chromium	2.6E-08	2.90E-09

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# Response to Comments

## Draft Remedial Investigation (RI) Report for AOC 6 TNT Subareas

Naval Weapons Station Yorktown Cheatham Annex  
Williamsburg, VA  
May 4, 2015

The comments below were received via an email dated February 9, 2015 from Gerald Hoover, U.S. Environmental Protection Agency (EPA), Region III. The Navy's response follows each comment.

### **Original EPA HYDRO COMMENT (provided 2/9/15)**

*The concentrations of arsenic and iron in the up-gradient monitoring wells MW-06 and MW-02 are not a sufficient line of evidence to demonstrate that the arsenic and iron concentrations in groundwater at the site are attributable to background conditions. The Navy should explain in more detail, and should provide additional data, that can clearly demonstrate that the concentrations of arsenic and iron in groundwater are indeed attributable to naturally occurring background conditions.*

**Navy Response (provided via email 3/6/15)**: Regarding the upgradient site background monitoring wells, MW01 and MW06 (not MW02 as indicated by the comment), when the CAX AOC 6 TNT Subareas RI UFP-SAP was prepared, the Yorktown-Eastover Aquifer was assumed to be the surficial aquifer underlying these subareas, based on the limited data available from the temporary groundwater sampling wells previously advanced at these subareas. However, soil boring data collected during the RI led to the identification of the Columbia aquifer as the underlying surficial aquifer. The Columbia aquifer is thin, discontinuous and present only in isolated areas underlying the Yorktown and CAX facilities. Where present, it ranges in thickness from 5 to 20 feet, and groundwater within this aquifer is locally influenced by nearby surface water bodies (*Final Background Study Report, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia*; CH2M HILL, 2011). Because the Columbia aquifer underlying the facilities is limited and discontinuous, and there are few CERCLA sites with the potential to have impacted the aquifer, the background groundwater investigation conducted in 2009 focused on the Cornwallis Cave and Yorktown-Eastover aquifers, and basewide background levels were not established for the Columbia aquifer. As stated in Section 5.1 of the *Final Background Study Work Plan, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia* (CH2M HILL, 2009), "background/upgradient groundwater quality for CERCLA sites overlying the Columbia aquifer will be evaluated on a site-specific basis." Since there are no available basewide background analytical data for the Columbia aquifer, it is logical and appropriate to turn to site-specific monitoring wells that are screened in the same aquifer as known groundwater impacts, clearly upgradient of onsite sources and impacted areas, and not downgradient of any other impacted sites as a reasonable means to evaluate localized groundwater background conditions. Monitoring wells MW-01 and MW-06 are located upgradient of where historic site activities occurred at the AOC 6 TNT subareas, and the concentrations of arsenic and iron in these wells are, therefore, representative of groundwater background conditions.

Regarding the groundwater arsenic and iron results for the AOC 6 TNT subareas, the concentrations in question are as follows:

Well	Total			Dissolved		
	Arsenic (µg/L)	Iron (µg/L)	Manganese (µg/L)	Arsenic (µg/L)	Iron (µg/L)	Manganese (µg/L)
MW01	6.3	16,000	710	6	16,000	700
MW02	21	36,000 J	220	20	37,000 J	200
MW03	33	32,000	210	25	29,000	170
MW04	16	19,000	400	17	19,000	410
MW05	26	24,000	360	22	23,000	280
MW06	33	30,000	340	32	30,000	330

J = Analyte present, value may or may not be accurate or precise

<sup>1</sup>Although manganese is not referenced in the EPA comment, it is included in the table above because of the Virginia Coastal Plain discussion that follows.

Overall, naturally-occurring arsenic, iron and manganese concentrations within the coastal plain of southeast Virginia are typically *highly variable* and *elevated* due to the soil composition, as shown in the table that follows:

**Max Background Values (Dissolved Fraction) for SE VA Navy Bases**

Constituent	Southside				Peninsula		
	Little Creek <sup>1</sup> (µg/L)	St. Juliens Creek Annex <sup>2</sup> (µg/L)	Oceana <sup>3</sup> (µg/L)	Norfolk Naval Shipyard <sup>4</sup> (µg/L)	Camp Peary <sup>5</sup> (µg/L)	WPNSTA Yorktown and CAX <sup>6</sup> (µg/L)	
						Cornwallis Cave Aquifer	Yorktown-Eastover Aquifer
Arsenic	69.4	15.4	12.4	11.9	N/A	2.5	6.2
Iron	29,800	94,000	6,590	14,000	20.6	1,510 K	1,670 K
Manganese	1,510	11,800	251	308	161	77.2	79.7

K – reported value may be biased high, actual value may be lower

<sup>1</sup> Baker Environmental and CH2M HILL, 2000. *Background Investigation for Naval Amphibious Base Little Creek, Virginia Beach, Virginia*. December.

<sup>2</sup> CH2M HILL, 2004. *Background Investigation Report Addendum for Groundwater, St. Juliens Creek Annex, Chesapeake, Virginia*. August.

<sup>3</sup> CH2M HILL, 2004. *Technical Memorandum Background Investigation Results for Select Inorganics, NAS Oceana, Virginia Beach, Virginia*. July.

<sup>4</sup> CH2M HILL, 2002. *Background Investigation, Norfolk Naval Shipyard, Portsmouth, Virginia*. May.

<sup>5</sup> Baker Environmental, 2002. *March 2003 Background Groundwater Study, Armed Forces Experimental Training Activity Camp Peary, Williamsburg, Virginia*. October.

<sup>6</sup> CH2M HILL, 2011. *Final Background Study Report, Naval Weapons Station Yorktown, Yorktown, Virginia, and Cheatham Annex, Williamsburg, Virginia*. May. (Note: Since the Cornwallis Cave aquifer is predominantly present west of the Camp Peary Scarp, and the Yorktown-Eastover Aquifer is predominantly present east of the Camp Peary Scarp, the maximum background values for both of these aquifers are included in this table)

In addition,

- Arsenic is commonly adsorbed to, or co-precipitated with, iron and manganese oxides, adsorbed to clay mineral surfaces, and associated with sulfide minerals. Natural dissolving or desorbing of arsenic from these source materials releases arsenic to groundwater.
- Iron oxides can be variable within soil as a result of chemical weathering (the “rusting” appearance on rocks).
- The arsenic occurrences correlate with elevated concentrations of iron and manganese, a strong

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indication that arsenic is naturally-occurring and not from a site release.

- Concentrations of naturally-occurring arsenic in groundwater vary regionally due to a combination of climate and geology (USGS, 2000)<sup>1</sup>.
- The U.S. Geological Survey (USGS) has collected and analyzed arsenic in potable (drinkable) water from 18,850 wells in 595 counties across the United States during the past two decades, and naturally-occurring arsenic concentrations in the coastal plain of southeast Virginia are typically detected above the MCL (see attached figure).

Therefore, the Navy maintains that the evidence from site data does not point to the concentrations of arsenic and iron in the Columbia aquifer groundwater at AOC 6 being attributable to a site release. In contrast, the evidence is consistent with the highly typical finding at CAX and other bases within the coastal plain of Virginia that the concentrations are attributable to naturally-occurring background conditions. Recommended text revisions to make this point in the RI report more clear are:

1. Section 4, 3<sup>rd</sup> paragraph – new text (in red) was added (and Footnote 7 removed):

The background screening values used to evaluate the soil and groundwater sampling data are the surface and subsurface soil background 95 percent upper tolerance limits (UTLs) (CH2M HILL, 2011) and groundwater concentrations from monitoring wells CAA06-MW01 and CAA06-MW06, respectively. Since CAX background concentrations for groundwater are not available for the Columbia aquifer, background/upgradient groundwater quality for CERCLA sites overlying the Columbia aquifer was evaluated on a site-specific basis in accordance with the Final Background Study Work Plan, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia (CH2M HILL, 2009). Monitoring wells CAA06-MW01 and CAA06-MW06 are located upgradient of where historic site activities occurred at the AOC 6 TNT subareas and are not downgradient of other CERCLA sites; therefore, the groundwater analytical data from these two monitoring wells are representative of groundwater background conditions.

2. Section 4.2.2, First bullet (added text in red):

- Total and dissolved arsenic exceeded the MCL and adjusted Tapwater RSL in five groundwater samples; however, all of the concentrations in monitoring wells within the study area boundary were below those detected in reference monitoring well CAA06-MW06, which is upgradient of the AOC 6 TNT Subareas. The arsenic concentrations were also higher compared in monitoring well CAA06-MW03, which is also upgradient of the former TNT Graining House, Sump, and Catch Box Ruins, since Penniman Lake was found to be recharging the surficial aquifer during the RI. Arsenic concentrations in groundwater at the AOC 6 TNT Subareas appear to be representative of naturally occurring conditions, as arsenic concentrations are typically elevated in the shallow coastal plains of southeast Virginia due to the aquifer composition and geochemical conditions. Arsenic is commonly adsorbed to, or co-precipitated with, iron and manganese oxides, adsorbed to clay mineral surfaces, and associated with sulfide minerals. Natural dissolving or desorbing of arsenic from these source materials releases arsenic to groundwater. In addition, the U.S. Geological Survey (USGS) has collected and analyzed arsenic in potable (drinkable) water from 18,850 wells in 595 counties across the United States during the past two decades, and naturally-occurring arsenic concentrations in the coastal plain of southeast Virginia are typically detected above the MCL (USGS, 2000).

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<sup>1</sup> United States Geological Survey (USGS). 2000. *Arsenic in Ground-water Resources of the United States*. <http://pubs.usgs.gov/fs/2000/fs063-00/fs063-00.html#HDR1>

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3. Section 4.2.2, Fourth bullet (added text in red):

- Total iron and manganese concentrations exceeded their respective adjusted Tapwater RSLs in each of the six groundwater samples. The maximum concentrations of total and dissolved iron detected in sample CAA06-GW02-1013 exceeded the respective concentrations detected in groundwater from reference wells CAA06-MW01 and CAA06-MW06, but were not significantly higher than the concentrations in reference well CAA06-MW06 and upgradient monitoring well CAA06-MW03. The concentrations of iron in groundwater are likely attributable to naturally occurring background conditions. With respect to total and dissolved manganese in groundwater samples, detected concentrations did not exceed those detected in groundwater in reference well CAA06-MW01. Similar to iron, manganese concentrations in groundwater are also likely attributable to naturally occurring, background conditions.

Iron and manganese concentrations are typically elevated in groundwater of the shallow coastal plain of southeast Virginia due to the aquifer composition and geochemical conditions. Iron oxides can be variable within soil as a result of chemical weathering. The ORP and DO values in listed in Table 2-3 suggest a more reducing environment at the AOC 6 subareas. Under these conditions, iron hydroxides and manganese oxides present in the soil matrix can reductively dissolve into soluble forms as evidenced by elevated iron and manganese concentrations within groundwater.

**Follow-up EPA Comment (provided via email 3/24/15):** We agree with Navy's response that, provided there are no base-wide background analytical data available for the Columbia aquifer, using site-specific monitoring wells is logical and appropriate. However, the Navy's assertion that MW6, which is approximately 25 feet from and more closely resembles the constituent concentrations in MW2, is representative of background is a not a reasonable assumption. It may be up-gradient of the site buildings, but MW6 lies so close to the ambiguous site boundary that it cannot be definitely identified as not impacted by site activities.

**Navy Response:** As shown on the attached groundwater contour figure (Figure 3-5 from the draft RI), monitoring wells MW01 and MW06 (and MW02) are located upgradient of where historic site activities occurred at the AOC 6 TNT subareas, and the concentrations of arsenic and iron in these wells are, therefore, representative of groundwater background conditions. The closeness of MW6 to the site boundary is not important. The establishment of a site boundary line on a map is a fairly arbitrary activity conducted before site-specific investigations take place to identify the actual nature and extent of contamination inside the site boundary. What is important is the upgradient versus downgradient position, as well as, the closeness of MW06 relative to the actual source areas that have been identified and delineated as part of the CSM of the site. The results show that the source areas at this site are the immediate vicinities of the TNT Catch Box Ruins and the former TNT Graining House Sump, where elevated concentrations of TNT and/or lead were found. MW06 is well upgradient of these delineated source areas, and is, therefore, appropriate as a site-specific background well.

Also, the similarity in concentrations between MW06 and MW02 is irrelevant. MW06 is clearly upgradient of the source areas within the site boundary for the site-related risk drivers (TNT and lead) identified during the RI and delineated in the updated CSM – the immediate vicinities of the TNT Catch Box Ruins and the former TNT Graining House Sump. MW02 is also upgradient of the source areas where the soil contaminant concentrations are driving risk and could also arguably be considered a site-specific background well. Therefore, the similarity in arsenic and iron concentrations between MW06 and MW02 is not remarkable. However, the Navy elected to be very conservative and not include MW02 as a background well in its evaluation since it is closer, though still clearly upgradient, of the delineated source areas.

As stated previously, arsenic and iron concentrations have been shown time and time again at CAX and other sites in the surficial aquifer of the Virginia Coastal Plain to be naturally elevated due to the mineral composition of the aquifer matrix and the geochemical conditions, and that natural background concentrations typically drive risk for human exposure to groundwater (i.e., remediation of higher-than-background concentrations of arsenic and iron down to background concentrations typically does not mitigate risk). There is no evidence in the CSM based on the nature of historical site activities to indicate that arsenic and/or iron would somehow logically be COCs at this site. The overwhelmingly simple explanation is that arsenic and iron concentrations are elevated as they typically are in the surficial aquifer at virtually all similar sites in the Coastal Plain of Virginia. Carrying these constituents forward to an FS would waste valuable resources formulating and evaluating remedial alternatives that are not warranted and stand little chance of being implemented.

In addition, the Columbia aquifer would not be a suitable potable water source.

Lastly, given the Columbia aquifer's sparse presence at CAX, there is no guarantee we would encounter it again if additional wells were installed to represent background further from the site boundary.

#### **EPA Biological Technical Assistance Group Comments**

1. *BTAG Comment #1: Table 2-2 Groundwater and Penniman Lake Surface Water Elevations: According to this table the groundwater elevations ranged from 4.39 to 6.35 feet above mean sea level (amsl) and the Penniman Lake surface water elevation was 8.06 amsl. This report does not indicate how deep Penniman Lake is, therefore, it seems reasonable that there is a direct connection between groundwater and the lake and the lake could be gaining or losing depending on conditions. The connection between groundwater and Penniman Lake should be clarified.*

**Navy Response:** The RI report does not dispute that a hydraulic connection exists between the groundwater of the surficial aquifer (Columbia aquifer) at AOC 6 and the adjacent surface water of Penniman Lake. This is clearly the case. However, during the RI field investigations at the time when concurrent measurements of the elevations of groundwater and the surface of Penniman Lake were made, as reported in Table 2-2, the elevation of the surface of Penniman Lake significantly exceeded the elevations of the water table in the adjacent Columbia aquifer at AOC 6. Regardless of the depth of Penniman Lake, these data indicate that the hydraulic pressure gradient at that time was directed from Penniman Lake to the adjacent surficial aquifer, indicating that Penniman Lake was recharging the Columbia aquifer. Moreover, it is stated in several places in the RI report (see text in Sections 6.2, 7.2.2, and 7.3.1) that these hydraulic pressure gradient conditions may not always exist, such that groundwater flow in the Columbia aquifer may at times potentially discharge into Penniman Lake (e.g., during times of drought when the water level in Penniman Lake may be lower).

2. *BTAG Comment #2: Figure 2-1 AOC 6 TNT Subareas RI Sample Locations: This figure identifies a berm to the north of the TNT Graining House and Catch Box Ruins. The text should explain the purpose and origin of the berm and why no samples were collected from it. The original topography of the area appears to be about 16 feet and the current top of the berm is approximately 30 feet (Figure 3-1) [see also Appendix J Ecological Risk Assessment, Section J.2.1]. The berm appears to be approximately 60 feet by 100 feet.*

**Navy Response:** The following footnote will be added in conjunction with the first reference to Figure 2-1:

The “berm boundary” on Figure 2-1 represents the remnants of an earthen berm that was installed during construction of the former PSLP and assumed to provide some protection should an explosion occur. Berms [or “bunkers” as they are referred to on historic drawings (Weston, 1999)]

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were constructed of various configurations (either completely surrounding or horseshoe- or L-shaped) around several of the former PSLP buildings where an unexpected detonation of explosive materials could occur. The berm is located outside of the footprint of the TNT Subareas; therefore, no sampling of this area is necessary.

3. *BTAG Comment #3: Figure 2-1: Previous comments identified the need for additional samples (surface water, sediment, and porewater) in King Creek adjacent to this site (e.g., Section 3.5.4 of this document also supports this position) and in the drainage feature from the dam to the creek, including the creek.*

**Navy Response:** Comment noted. As stated in the responses to the referenced previous comments, the collection of samples from King Creek will occur as part of the Penniman Lake investigation. The type, number, and parameter list for any additional samples from King Creek will be determined during a future scoping session for the Penniman Lake investigation.

4. *BTAG Comment #4: Figure 2-1: No samples were collected from the graining house or the sump. Even if these were constructed of concrete, the integrity of the floor may have been compromised and allowed contaminants to escape to an area that has not been sampled. These contaminant concentrations may still be in the migration pathway. An explanation should be provided on why samples were not collected from these areas.*

**Navy Response:** On June 4, 2013, a conference call was held with the CAX Partnering Team and EPA technical support (attendees included Scott Park/Navy, Sue Haug/EPA, Peter Knight/EPA BTAG, John McCloskey/EPA BTAG, Wade Smith/VDEQ, Laura Lampshire/CH2M HILL, Marlene Ivester/CH2M HILL, Bill Kappleman/CH2M HILL, and Roni Warren/CH2M HILL). During this meeting, it was agreed that the sump would be field checked during the RI, and if residual material was observed, a 3-point composite sample of the sump material would be collected and analyzed. As documented in Section 2.1.4 of the Draft RI Report, the sump was inspected on September 19, 2013. Since only organic material and flakes of scraped concrete were recovered, and no residual material was present, there was no residual material to sample.

5. *BTAG Comment #5: Section 6.3 on page 6-2 states that since Penniman Lake has now received a site designation (AOC 9), any further evaluation of surface water and sediment offshore of the AOC 6 TNT Subareas has been deferred to the Penniman Lake Site Inspection (SI). This approach would be acceptable if sediment sampling as part of the Penniman Lake SI was sufficient to characterize the nature and extent of explosives at AOC 6. However, sediment sampling in Penniman Lake adjacent to AOC 6 is limited (only one sample) and additional sampling as part of the Penniman Lake SI is recommended. Any additional sampling needs to consider the fact that activity at AOC 6 predates construction of the dam which likely results in different migration pathways than those present today.*

**Navy Response:** Comment noted. Additional surface water and sediment sampling has occurred as part of the Penniman Lake SI, and the analyses included explosives. The number and location of these samples were agreed to as part of the Penniman Lake SI (Step 2) SAP, and the results are currently being evaluated as part of the Penniman Lake SI.

In addition, it should be noted that one surface water and two sediment samples were collected from Penniman Lake during the EPA-led SI of the former Penniman Shell Loading Plant (Weston, 1999) at the suspected point of discharge of runoff from the TNT catch basin. The analyses included explosives, and the report concluded there was no analytical data (explosive or otherwise) which indicated the TNT subarea was currently impacting Penniman Lake. The AOC 6 SI surface water and sediment samples (collected adjacent to the TNT subareas and including explosives analysis) likewise concluded no potential unacceptable ecological risks were identified with exposure to surface water or sediment (surface and subsurface) within this subarea (CH2M HILL, 2012).

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6. *BTAG Comment #6: Page 6-4, Section 6.5.2 Aquatic Habitats: The potential for risk from contaminants to ecological receptors (e.g., groundwater to surface water) has existed at this site since World War I. This means the contaminants may have already reached Penniman Lake or King Creek and may be different than the contaminants found in the groundwater during this study. This supports the need to assess the historical groundwater contaminant migration pathway, potentially including the collection sediment samples for use in the ecological risk assessment.*

**Navy Response:** The need to assess a possible (and hypothetical) historical groundwater contaminant migration pathway was not previously presented as a concern during any of the CAX AOC 6 TNT Subarea RI SAP scoping sessions. In addition, the CAX Tier 1 Partnering Team agreed Penniman Lake (and King Creek) surface water and sediment should be evaluated under one comprehensive study, not split into multiple investigations. Therefore, the AOC 6 TNT subarea RI ERA will not include sediment samples. As stated in the response to BTAG comment #5, additional surface water and sediment samples have been collected from Penniman Lake and are being evaluated under the Penniman Lake SI. As stated in the response to BTAG comment #3, the type, number, and parameter list for any additional samples from King Creek will be determined during a future scoping session for the Penniman Lake investigation.

**BTAG Comments Related to Appendix J Ecological Risk Assessment:**

7. *BTAG Comment #7: Page J-15, Section J.4.1 Medium-Specific ESVs: For both soil and surface water the text indicates that when more than one ESV (ecological screening value) was available, "...the lowest of these values was typically selected." Please identify which contaminants did not have the lowest ESV selected and state the reasons why this approach was used.*

**Navy Response:** The lowest value was always selected. The word "typically" will be removed from the text for both of the instances referenced in the comment.

8. *BTAG Comment #8: Page J-19, Section J.5.3.2 Terrestrial Food Web Exposures: The text states "...although chemicals that exceeded the MATC, but not the LOAEL, were discussed for possible risk management considerations." The results of this discussion including the possible risk management consideration need to be included in this section.*

**Navy Response:** Since this situation did not arise in this particular ERA, the cited text is not relevant to the AOC 6 TNT Subarea ERA and will be deleted.

9. *BTAG Comment #9: Page J-21, Section J.5.4 Aquatic Habitats: The use of mean site concentrations are not appropriate for determining risk to ecological receptors that are immobile or have a limited home range. Maximum concentrations must also be considered when assessing risk to lower trophic level receptors.*

**Navy Response:** Maximum concentrations were used to select Step 2 COPCs consistent with EPA and Navy ERA guidance. For Step 3A, COPC selection for groundwater considered both background (upgradient well) concentrations and central tendency chemical concentrations (since the endpoints evaluated were based on communities/populations and not individual organisms), as well as the magnitude and frequency of ESV and background exceedances (which account for maximum concentrations).

10. *BTAG Comment #10: Page J-22, Section J.5.5.2 Aquatic Habitats: The text states "...groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota." Knowing when the dam was installed would help support or refute*

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*the first portion of this quote. Because no sampling has occurred in King Creek and only one sediment sample is located in Penniman Lake adjacent to this site, support for this position is not sufficient.*

**Navy Response:** Please see the response to BTAG Comments 5 and 6.

11. *BTAG Comment #11: Page J-25, Section J.6 Uncertainties: Assessing ecological risk to lower trophic level receptors needs to consider maximum, not just mean, concentrations. The Wildlife Factors Handbook does not evaluate lower trophic level ecological receptors that are immobile or have a limited home range nor does it “specify” the use of average media concentrations. Citing this document to support using mean versus maximum concentrations for lower trophic level receptors is not appropriate.*

**Navy Response:** Maximum concentrations were used to select Step 2 COPCs consistent with EPA and Navy ERA guidance. For Step 3A, COPC selection considered background soil UTLs and central tendency chemical concentrations (since the endpoints evaluated for terrestrial lower trophic level receptor groups were based on communities or populations and not individual organisms), as well as the magnitude and frequency of ESV and UTL exceedances (which account for maximum concentrations).

The referenced bullet in the uncertainty section has been modified to read as follows:

- Mean Versus Maximum Media Concentrations – As is typical in an ERA, a finite number of samples of environmental media were used to develop the exposure estimates. The maximum concentration provides a conservative estimate of risk for immobile biota or those with a limited home range. The most realistic exposure estimates for mobile upper trophic level species with relatively large home ranges are those based on central tendency estimates of chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the *Wildlife Exposure Factors Handbook* (USEPA, 1993), which specify the calculation of an average daily dose. Given the mobility of the upper trophic level receptor species used in the ERA, the use of maximum chemical concentrations (rather than 95% UCL and mean concentrations) in the SERA (Step 2) to estimate the exposure via food webs is very conservative. This conservatism was reduced to more realistic levels in the values selected for use in the BERA (Step 3A) food web evaluation.

In cases where adequate spatial sampling coverage exists, central tendency estimates of chemical concentrations in exposure media are also appropriate for evaluating potential risks to populations of lower trophic level receptors because the members of the population are expected to be found throughout a site (where suitable habitat is present), rather than concentrated in one particular area. While effects on individual organisms might be important for some receptors, such as rare and endangered species, population- and community-level effects are typically more relevant to ecosystems. The 95% UCL of the arithmetic mean was typically used quantitatively in the BERA portion of this ERA to represent the average exposure scenarios during COPC selection.

12. *BTAG Comment #12: Page J-26, Section J.7 Risk Summary and Conclusions: The text states “Based on the results of this evaluation, groundwater is not a significant transport medium for site-related constituents to Penniman Lake or King Creek, and site-related constituents that might reach these water bodies via groundwater would not pose an unacceptable risk to aquatic biota.” Based on this report, groundwater may discharge to both of these surface water bodies. Depending on how long the dam has been operational compared with AOC 6 TNT being constructed, groundwater flow may have been different than today (e.g., more flow toward Penniman Lake [or the wetland that was present before the lake]). The text does indicate that groundwater tends to flow toward King Creek. This means that additional sediment samples may be warranted from King Creek adjacent to (in the groundwater discharge area), upstream, and downstream of this site. In addition, more sediment samples need to be collected in*

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*Penniman Lake near this site in the groundwater discharge area. These would be in addition to Penniman Lake sediment sample CAA06-SD01.*

**Navy Response:** Please see the response to BTAG Comments 5 and 6.

#### **EPA TOXICOLOGIST'S COMMENTS**

*Overall, the methodologies to complete the human health risk assessment appear appropriate; however, the following comments and recommendations must be considered as the draft RI is finalized.*

##### *Major Concerns:*

- 1. Agree with the recommendations on page 8-2 in Section 8.2, except for the recommendation #3. For groundwater, the comparison to background should include a more robust statistical analysis than comparing the range of two background wells (one of which is debatable, see comment under Section 4 below) to the range of constituent concentrations at monitoring wells. The iron and arsenic concentrations in the monitoring wells may be attributable to naturally occurring background levels; however, the current analysis does not definitively support this conclusion. Recommend including groundwater as needing further action unless background analysis is improved.*

**Navy Response:** Refer to the response to the EPA Hydro comment above and the response below regarding MW06.

- 2. Lead was not identified as a COPC in Section H.6.2. Risk Assessment Results. This determination is correct using the mean concentration in soil and subsurface soil and the exposure parameters described in the Table 4s; however, the highest concentration observed, 1,100 mg/kg, was from a subsurface soil sample from within the Catch Box Ruins and was identified as an outlier using ProUCL 5.0. The next highest concentration, 580 mg/kg, was from a surface soil sample also within the Catch Box Ruins. Section H.6.4 addresses the possibility of lead as a hot spot but fails to provide a strategy moving forward. Recommend calculating human health risk of exposure to lead in surface and subsurface soils using concentrations within Catch Box Ruins (using sample Stations CAA06-SO01 and SO26).*

**Navy Response:** Agree. We will evaluate risks associated with exposure to lead in the Catch Box Ruins, using samples CAA06-SO01 and SO26. Risks associated with exposure to surface soil, and combined surface and subsurface soil from these samples, will be evaluated, based on the exposure scenarios presented in Appendix I Table 1 evaluated in the HHRA. The RI text (and Appendices H and I) will be updated as needed following this evaluation.

##### **Nature and Extent of Contamination (Section 4)**

- Page 4-1, 3<sup>rd</sup> paragraph – disagree with selection of MW-6 as a source of background concentrations for groundwater. This well, while outside the arbitrary TNT Subareas Study boundary, is more similar and closer in location to MW-2 than MW-1 (the other background source well).*

**Navy Response:** The attached figure (Figure 3-5 from the draft RI report) shows the potentiometric surface contour map for the surficial aquifer at the site. Based on the water level data collected during the RI, this map shows that both MW-1 and MW-6 are clearly not downgradient of any of the source areas at the site. MW-2 is arguably upgradient of the significant potential source areas at the site as well, but it is close enough to the edge of the berm boundary that we have conservatively

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considered it potentially impacted. Even in a scenario in which Penniman Lake was not recharging the surficial aquifer (as it was at the time water-level measurements in Figure 3-5 were collected), groundwater flow would be expected to be directed to the northeast toward Penniman Lake, such that MW-1 and MW-6 would continue to be not downgradient of the potential source areas at the site.

#### **Human Health Risk Assessment (Section 5)**

- *Page 5-3 – the COCs identified appear appropriate*

**Navy Response:** Comment noted.

- *Page 5-3, last paragraph – replace “were found to” with “may,” such that the arsenic and iron concentrations in soil “may be” attributable to naturally occurring background conditions. For a more definitive conclusion, a statistical comparison of estimated background concentrations with observed site concentrations is needed.*

**Navy Response:** The text will be revised as requested.

- *Page 5-3 – please add text discussing risks associated with exposures to chromium VI to Appendix H, Section H.8, HHRA Summary.*

**Navy Response:** The text included in Section 5 concerning chromium VI will also be included in Appendix H, Section H.8.

- *Page 5-4, first paragraph – delete comparison of iron ingestion for on-site receptor to recommended daily allowance and conclusion that iron ingestion from on-site ground water would be below the recommended daily allowance (RDA). This statement ignores that the iron intake from the ground water is not the sole source of iron and would be combined with regular dietary intake. The combined dietary intake, from ground water and diet, may be greater than the RDA; unfortunately, the text does not provide a quantitative comparison of the RDA with a combined iron intake, diet and on-site ground water, for any of the receptors.*

**Navy Response:** The text will be deleted as requested.

#### **Chemical Fate and Transport (Section 7)**

- *Page 7-5, top of page – The sentence that only 3 inorganic constituents were identified as COCs in surface soil is followed by a sentence that indicates that lead was one of the 3 inorganic COCs. Lead was also labeled as a COC on page 7-7, first bullet. However, lead is not included as a COC in Section 5 or identified as such in Appendix H. Please clarify that lead was a COC in the ecological RA. A table outlining the COCs in each assessment at the beginning of Section 7 would be helpful.*

**Navy Response:** Table 7-1, which is referenced in the first paragraph of section 7, summarizes the COCs at the TNT subareas by media and risk (that is, human health or ecological). It identifies lead as an ecological COC and not a human health COC. No changes will be made to this table. However, the first two sentences on Page 7-5 will be revised to clarify that arsenic and hexavalent chromium have been identified as human health COCs only while lead has been identified as an ecological COC only.

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- *Page 7-7, last bullet – Definitively attributing arsenic and iron concentrations in soil to naturally occurring background is not possible given the information available and lack of statistical analysis. Arsenic and iron may be attributed to background. Replace “are” with “may be.”*

**Navy Response:** Refer to the response to the Hydro comment above. A “statistical analysis” is not feasible since there is not an extensive background data set for the Columbia aquifer at CAX, since it has such a limited extent. The reasonableness of using site-specific background data for comparison and evaluation in these circumstances is appropriate, logical and called for in this situation in the Background Study Work Plan for Yorktown and CAX. The evidence shows that the COCs at this site are the detected explosives and lead. The weight of evidence does not suggest that constituents such as arsenic and iron that have been well documented to be naturally elevated in soil and surficial aquifer groundwater at virtually every site at CAX are attributable to site activities at the AOC 6 TNT Subareas.

### **Conclusions and Recommendations (Section 8)**

- *Page 8-1, 1<sup>st</sup> paragraph – The comparison to background should include a more robust statistical analysis than comparing the range of two background wells (one of which is debatable) to the range of constituent concentrations at monitoring wells. The iron and arsenic concentrations in the monitoring wells may very well be attributable to naturally occurring background levels; however, the current analysis does not definitively support this conclusion. Recommend including groundwater as needing further action unless background analysis is improved.*

**Navy Response:** Refer to the response to the previous comment.

- *Page 8-2, Section 8.2 – Recommendations*
  1. *FFS for TNT and lead in soil → Agree.*  
*No further action for arsenic and chromium VI in soil → Agree.*
    - *Provide reference to source of background analysis. A table may be beneficial comparing the 95% UTL for surface soil and for subsurface soil against the observed arsenic and chromium concentrations. This is the only place in document that this comparison is made and a transparent explanation is beneficial.*
  2. *No further action for 2-nitrotoluene in soil → Agree.*
  3. *No further action for arsenic and iron in groundwater → Disagree. Background comparison not sufficient to make this determination.*

**Navy Response (to #1):** There is an explanation in Appendix H that discusses arsenic being within the range of background. This text will be brought up to Section 5.3 of the RI, as well. Also, the table in the lower left corner on Figure 8-1 shows the surface and subsurface soil background UTLs for arsenic, while the tables for the individual sample results provide the arsenic concentrations. It's all on the same figure to allow for an easy comparison. The background comparison is just related to arsenic, as there are no background soil UTLs for chromium VI. The following revisions (red text) will be made to make the main RI text more clear/transparent:

Section 5.3 – added paragraph (to be inserted immediately before the “The concentration of hexavalent chromium . . .” paragraph):

A comparison of site concentrations to background concentrations was not used to select the COPCs. Therefore, it is possible that any of the metals identified as COPCs and COCs may be associated with background conditions. Arsenic was identified as a COC in surface and subsurface soil. Arsenic concentrations in surface and subsurface soil ranged from 1.1 mg/kg

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to 20.9 mg/kg. More than half of these detections were below the 95 percent UTL from the CAX/Yorktown background values of 6.36 mg/kg and 5.54 mg/kg for surface and subsurface soil, respectively. Therefore, it is possible some of the risk associated with exposure to arsenic in soil is from background conditions.

Section 8.2 – revisions to Item #1, second paragraph:

No further action is recommended for arsenic and hexavalent chromium. The arsenic concentrations are within the range of the soil background 95% UTLs (CH2M HILL, 2011), as shown on **Figure 8-1**. Hexavalent chromium was not detected in surface soil, and in subsurface soil, the risk to a residential receptor would fall within the acceptable risk range for this constituent, as discussed in Section 5.3.

**Navy Response (to #3):** Please refer to the response to the “Page 7-7, last bullet” comment.

***Laboratory Analytical Data (Appendix G)***

- Table G-3 – Table heading incorrectly labels the data as Raw Surface Soil. The data in the table are for groundwater.

**Navy Response:** The table header for raw groundwater analytical data in Appendix G will be revised to indicate groundwater data.

***Draft Human Health Risk Assessment (Appendix H)***

- *Page H-4, Section H.3.2 – Selection of COPCs – Disagree with utilization of MW-6 as source of background groundwater concentrations. In addition, the comparison to background should rely on a more robust statistically significant analysis than comparing maximum constituent levels.*

**Navy Response:** Refer to previous comment responses above.

- *Page H-5, Section H.4.1 – Conceptual Site Model for Human Health – Recommend including brief explanation, such as that included in Section 5.2, as to why the inhalation route is not a complete exposure pathway prior to bulleted list of current receptors and complete exposure routes.*

**Navy Response:** The following text from Section 5.2, which is also included in Section H.2, “Since historic site use is not associated with significant volatile organic compound (VOC) contamination, and volatile constituents were not found to be potential constituents of concern during previous investigations, VOCs were not included in groundwater analysis. Therefore, the groundwater to air pathway is not considered a complete exposure pathway” will be repeated in Section H.4.1.

- *Page H-12, Section H.6.2.3 – Current Child Recreational User (as well as other relevant areas of document) – Recommend removing phrase “conservatively used to evaluate recreational exposure to soil,” as this statement fails to provide meaningful information to the bullets. More appropriate in uncertainty section or not included in document at all, due to inherent ‘conservatism’ in risk assessment.*

**Navy Response:** The phrase “conservatively used to evaluate recreational exposure to soil” will be deleted, and instead the sentence will be changed to “IEUBK model (Tables 11.3a and 11.3b, Figure 11-1, Appendix I) demonstrated no adverse effects above acceptable levels associated with exposure to lead for a residential or recreational child”.

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- **Section H.7:**

- *Page H-15, Section H.7.1, 4<sup>th</sup> paragraph – Delete: “Therefore, it is possible that some of the risk associated with exposure to arsenic in soil is from background conditions.” This statement is misleading, as there were arsenic concentrations that exceeded the 95% UTL from the CAX/Yorktown background and contributed to the risk calculation.*

**Navy Response:** Since background concentrations of arsenic in soil at this site, across CAX, and across the coastal plain of Virginia are well documented to frequently exceed risk-based screening criteria, there is nothing misleading about this statement, and the suggested deletion is not necessary.

- *Page H-16, Section H.7.2, 1<sup>st</sup> paragraph – Recommend: “... generally conservative and reflect ~~worst-case~~, or upper bound, assumptions for the exposure.” The exposure factors are upper bound assumptions and the ‘worst-case’ descriptor is undefined.*

**Navy Response:** The text will be revised as requested.

- *Page H-16, Section H.7.2, 3<sup>rd</sup> paragraph – Delete: “During many construction projects, clean fill material... after any construction activities.” The information provided by these 3 sentences is conjecture and does not present substantive information critical to the risk assessment.*

**Navy Response:** The sentence will be deleted as requested.

- *Page H-16, Section H.6.3, 1<sup>st</sup> paragraph – Delete: “The noncarcinogenic toxicity factors are most likely an overestimate of actual toxicity.” Conjecture.*

**Navy Response:** The sentence will be deleted as requested.

- *Page H-16, Section H.6.3, 2<sup>nd</sup> paragraph – Delete: “...however, most of the experimental studies indicate the existence of a threshold value.” Incorrect. A threshold for carcinogenicity cannot be determined by a single experimental study, and the statement that ‘most’ experimental studies support a threshold is not supported.*

**Navy Response:** The text will be deleted as requested.

- *Page H-16, Section H.6.3, 2<sup>nd</sup> paragraph – Rewrite: “Uncertainty is also associated with the application of the ~~MMOADA~~AFs for chromium ~~due to its mutagenic MOA~~; this may overestimate or underestimate risks.*

**Navy Response:** The text will be revised as requested.

- *Page H-16 – H-17, Section H.6.3, 3<sup>rd</sup> paragraph – Delete. PPRTVs are supported by the Agency.*

**Navy Response:** The text will be modified to indicate “provisional toxicity values (such as values from ATSDR, HEAST, California EPA, and New Jersey DEP)...” The text was not intended to indicate that the provisional values were from the PPRTV database.

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- *Page H-16 – H-17, Section H.6.3, 4<sup>th</sup> paragraph – Delete. The ‘true’ cancer risk is unknown and cannot be predicted to be ‘less’ than the predicted value.*

**Navy Response:** The last sentence in the paragraph will be deleted.

- *Page H-16 – H-17, Section H.6.3, 5<sup>th</sup> paragraph – Delete. The interspecies uncertainty is captured in the interspecies uncertainty factor in the development of the RfD/RfC and is addressed in the toxicity assessment.*

**Navy Response:** The paragraph will be deleted as requested.

- *Section H.78 – Human Health Risk Summary – The COCs identified appear appropriate.*

**Navy Response:** Comment noted.

- *Section H.8 – Human Health Risk Summary – Delete text concluding that iron ingestion from on-site groundwater would be below the recommended daily allowance (RDA) (a reference for the RDA was not provided). This statement ignores that the iron intake from the groundwater is not the sole source of iron and would be combined with regular dietary intake. The combined dietary intake, from groundwater and diet, may be greater than the RDA; unfortunately, the text does not provide a comparison of the RDA with a combined iron intake, diet and on-site groundwater, for any of the receptors.*

**Navy Response:** The text will be deleted as requested.

#### **Draft Human Health Risk Assessment Tables (Appendix I)**

- *Reference EPA, 2014 → EPA, 2014c throughout Table 4s.*

**Navy Response:** On 3/6/15, clarification for this comment was requested, as it is unclear what is being asked/requested. Do the RAGS D tables and text references need to be the same? We only have one EPA 2014 in the Table 4s, but in the text we have more, and therefore, the document reference as EPA, 2014 on the Table 4s is reference as EPA, 2014c in the text.

- *Table 4.1.CTE (and elsewhere) – Recommend ingestion rate for child of 50 rather than convoluted time-weighted average for birth to <6 years.*

**Navy Response:** Per our discussion with the EPA RPM on 2/19/15, no change will be made to the HHRA calculations in Table 4.1.CTE for the AOC 6 TNT Subareas RI; however, should this be a change made for future documents? If so, what is the basis (reference) for the ingestion rate for a child of 50 mg/day? The time-weighted average is what is/has been used previously, based on the same method EPA has used to develop the RME ingestion rate for the child in EPA’s 2014 Human Health Evaluation Manual, Supplement Guidance: Update of Standard Default Exposure Factors. Please clarify.

- *Table 4.2.RME (and elsewhere) – construction worker – Please justify/clarify exposure duration of 1 year for construction worker ingestion of surface and subsurface soil. Support for this parameter was not found in the reference provided.*

**Navy Response:** The duration of 1 year for the construction worker was from Attachment B of EPA, 1991 referenced on Table 4.2.RME. “For certain outdoor activities in the commercial/industrial

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setting (e.g., construction or landscaping), a soil ingestion rate.....Thus, exposure frequency would generally be less than one year...”

- *Table 4.2.RME – resident (child/adult) – The age-adjusted ingestion rate of soil is not generally used to calculate the lifetime cancer risk for a resident (child/adult). The cancer risk is calculated for the child and for the adult, individually, and the cancer risks are then summed. It is recommended that the parameters for the child/adult resident are removed.*

**Navy Response:** The EPA RSL table uses age-adjusted ingestion rates. Is it only appropriate to use them when calculating RSLs but not when calculating site risks? Please provide the guidance indicating age-adjusted ingestion rates should not be used to calculate lifetime cancer risks. Additionally, this is the approach that has been used for calculating residential risks for all recent HHRA. As per our discussion with the EPA RPM on 2/19/15, no change will be made to the HHRA calculations in Table 4.1.RME.

- *Table 4.2.RME – construction worker – the Exposure Factors Handbook recommends a soil to skin adherence factor of 0.3; compared to the 0.12 provided in the draft table. Please clarify or use 0.3 from EFH.*

**Navy Response:** The SSAF factor for construction worker will be changed to 0.3.

- *Table 4.3.RME – adult base worker, tap water – ingestion rate of water – the footnote states that 1.25 is half the value from EPA, 1991, but the reference in the table is EPA, 2014. Please clarify or correct footnote.*

**Navy Response:** The footnote will be clarified to indicate as recommended by EPA, 1991, one half the adult resident ingestion rate of water (from EPA, 2014) used for the industrial worker.

- *Table 4.3.CTE – adult base worker, tap water – ingestion rate of water – assumes half ingestion rate of adult resident from EF Handbook but the adult intake rate was updated to 2.5 from 2. Please clarify or use 1.25 L/day.*

**Navy Response:** The adult resident RME ingestion rate of water is 2.5 L/day. However, as shown on Table 4.3.CTE, the adult resident CTE ingestion rate is 0.99 L/day. Therefore, no change will be made.

- *Table 5.1 – insert footnote describing process for selecting RfDs for 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene, which do not have RfDs, based on 2,4-dinitrotoluene.*

**Navy Response:** A footnote will be added stating: “as included on the RSL table, the RfD for 2,-dinitrotoluene is used for 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene”.

- *Table 6.1 – Change column heading ‘EPA Carcinogen Group’ to ‘Carcinogenicity Classification’ – not all the carcinogenicity classifications are based on EPA documents.*

**Navy Response:** The heading will be changed from the standard RAGS Part D table heading as requested.

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- *Table 6.1 – Is the source for the chromium VI carcinogenicity classification CalEPA? Could not locate NJDEP document on chromium VI.*

**Navy Response:** The source of carcinogenicity classification is IRIS. This will be added to Table 6.

- *Table 7.6.CTE – The cancer risk for the ingestion route CTE in the future construction worker could not be verified. Agency calculated risks were:*

	calculated by Agency	draft HHRA
24dinitrotoluene	3.4E-08	3.7E-09
246trinitrotoluene	4.3E-06	4.70E-07
2nitrotoluene	5.8E-07	6.50E-08
arsenic	4.9E-07	5.40E-08
chromium	2.6E-08	2.90E-09

**Navy Response:** As per our discussion with the EPA RPM on 2/19/15, Table 7.6.CTE was re-checked by the HH risk assessor and no errors were found with the calculations in the draft HHRA.



#### Legend

- Staff Gauge
- Groundwater Sample Location
- Groundwater and Surface/Subsurface Soil Sample Location
- Topographic High Point (dashed where approximated)
- Surficial Aquifer Potentiometric Surface Contour (dashed where inferred)
- Approximate Direction of Groundwater Flow
- Approximate AOC 6 TNT Subareas Study Boundary

- Berm Boundary
- Former TNT Graining House Sump/Former Catch Boxes boundary

Notes:  
 4.96 = Groundwater Elevation amsl  
 8.06 = Surface water Elevation amsl

Figure 3-5  
 Surficial Aquifer Potentiometric Surface Contours – August 22, 2014  
 AOC 6 TNT Subareas Remedial Investigation  
 Cheatham Annex  
 Williamsburg, Virginia

